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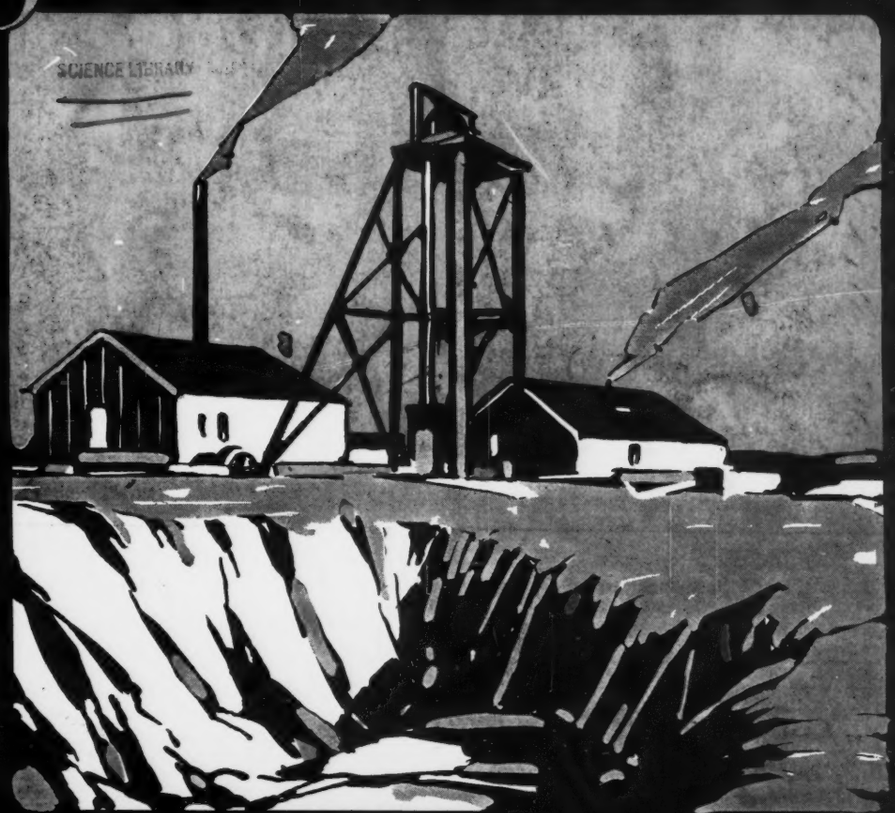
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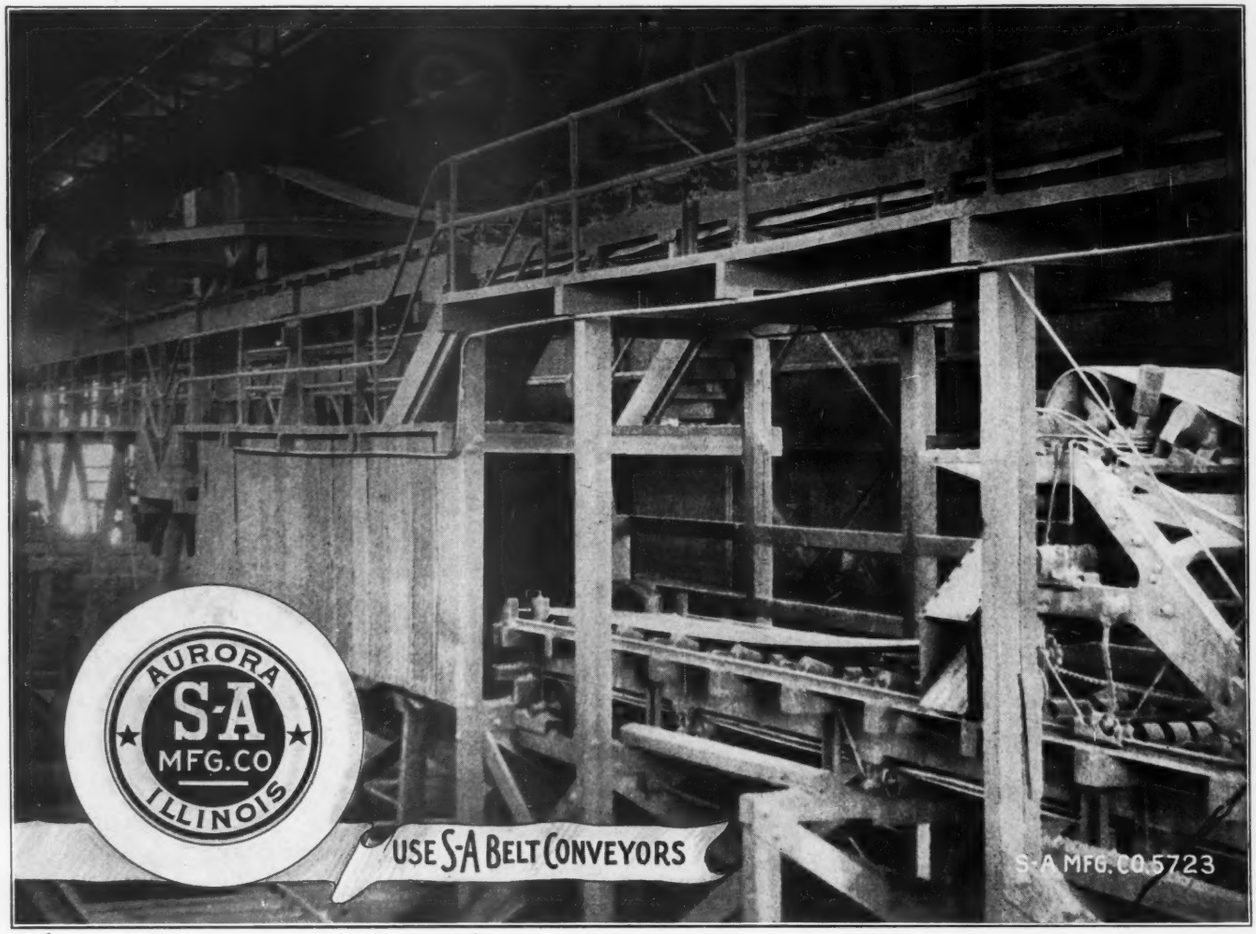

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1922 REVIEW NUMBER and YEAR BOOK of the

ENGINEERING & MINING
JOURNAL-PRESS

JOSIAH EDWARD SPURR, *Editor*
Tenth Avenue at 36th Street, New York City

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The Year Book Number

ENGINEERING AND MINING JOURNAL-PRESS is in its sixty-third year, the *Press* having been founded in 1860, and the *Journal* in 1866. As I explained in the issue of Dec. 9, there have been already forty-three annual numbers, the study of which shows a gradual evolution in size and construction. The Annual Review has grown to be as much of an institution as the *Journal-Press* itself. We have recognized the permanency, and this year we call it the *Annual Review Number and* YEAR BOOK.

I have honest pride in knowing that no mining journal has ever had the kind of editorial staff that the *Journal-Press* now has. No fewer than four members of the staff have written comprehensive and successful books on various phases of mining. But all that is insignificant as compared with the power behind the Year Book, to which experts, specialists, and leaders in various departments of the mineral industries have gladly contributed their share of wisdom and experience. You cannot find the equal of this varied group in any one mining volume you can name. Our gratitude to them—our appreciation of their fine public spirit—is profound. So, believing that we are under the best auspices that have ever obtained as to publisher, editorial staff, and contributors, we offer our very special Annual Effort to you—the subscriber and reader.

J. E. SPURR

MINING IN 1922

General Review

Recovery of Copper Companies and Efforts of Big Producers to Stabilize Operations Spectacular Features of 1922—Labor Situation Reverses Itself—No Benefit From Tariff—Silver Producers' Eyes on Future

By A. H. Hubbell
Managing Editor

ATTENTION during 1922 was largely focused on the copper-mining industry, which underwent a change from a state of almost complete stagnation at the beginning of the year to one of activity by July, when almost every important producer was working. Thus, hopes were realized which more than once had been deferred the year before. This increase in activity was not accompanied by a corresponding spurt in the industries producing the other metals. Iron mining was tardily resumed after a hard winter and, despite handicaps, made a fair showing for the year. Gold mining, at home, improved somewhat, and lead and zinc producers responded in varying degree to improved prices for their metals, but the marked revival was in copper production. This was only natural, as production of no other metal had been so curtailed.

The factor of labor supply was decidedly in the operator's favor at the beginning of the year. Wages had fallen and continued to fall. Labor was docile, as unemployment was widespread. In many places special relief measures were necessary. This situation began to change with the resumption of operations by Anaconda. To protect their supply of skilled labor, other copper producers were compelled to follow suit. Forces were rebuilt slowly. Long idleness had driven miners into other kinds of work, which doubtless in many cases proved congenial, and prohibition (it is said) and restrictions on immigration were tending to exclude foreign workers. Thus a competition for labor was established; wages ceased falling and began to rise. By the end of the year, increases in several instances had been recorded, and the metal-mining industries in general were confronted with the serious problem of obtaining sufficient experienced workers.

In a year noted for labor disturbances at home and abroad, the mining industries of the United States, with the exception of the coal industry, were conspicuously free from such disorder. The absence of strikes was as notable as in the preceding year, both years in this respect contrasting markedly with 1919, when twenty strikes occurred in as many different camps. This freedom from disturbance was, as already indicated, due to the condition of unemployment that existed.

Fortunately, slight inconvenience was experienced from the strikes of the coal miners and the railway shopmen, the former of whom went out in April and the latter in July. Coal stocks were ample in most districts and curtailment of operations in many places helped to eke them out. Here and there, car-shortage or other transportation difficulties interfered with operations; but, in the main, high freight rates were a more serious deterrent. Some districts were almost completely shut down owing to these, and others could ship only certain classes of ore. Rates were cut 10 per cent horizontally in July, which, though helping somewhat, did not stimulate activity immediately. It is easier to shut down than to resume.

Costs of supplies, as shown by index numbers of commodity prices, rose gradually but appreciably during the year, Dun's figure for Jan. 1, 1923, being $185.6357, as compared with $164.444 on Jan. 1, 1922.

During the year the Fordney-McCumber Tariff Bill became law, which naturally increased prices. Apparently only speculators profited, however, for no result on operations was evident following its passage. The situation regarding mine taxation remained unchanged in general. No legislation to ease the burden on operators was passed, and the volume of cases awaiting consideration at Washington was still discouragingly large.

Gold mining continued to emerge from the state of depression into which it had sunk during the war. Conditions were a little easier with the greater abundance of labor and somewhat lower costs, though still far from favorable and permitting for the most part only large-scale and well-financed producers to operate. Despite the fact that the fight was lost for the government bonus on new gold provided in the McFadden bill, a new movement was begun to secure a bounty to stimulate production. Abroad, producers who had been enjoying the benefit of the so-called premium, resulting from the exchange situation, notably those in South Africa and Australia, found themselves in an increasingly bad position as sterling exchange strengthened. The inability of workers on the Rand to see why wages should be cut, together with their objection to an attempted lowering of the "color bar," led to serious revolutionary disorder in the gold mines there early in 1922, which shut down all properties, some of them for good. Recovery was slow the rest of the year.

Domestic silver producers, including those who mined other metals carrying silver, continued to enjoy the advantage of dollar silver by virtue of the Pittman Act. Uncertainty as to the future when the act shall have expired gave concern, and measures that might improve the position of the metal then were studied.

Three events stand out in the history of the year. Anaconda acquired American Brass, thereby insuring an outlet for its copper and zinc, following this later with the acquisition of the low-cost producer, Chile Copper. Calumet & Hecla announced a merger with several of its subsidiaries, and rumors were afloat of plans to enter manufacturing. These attempts to stabilize metal-mining business and to safeguard it against the vagaries of economic forces evidently mark the beginning of a new epoch. The tendency to consolidation in the iron and steel industry was marked, and several mergers were effected. On the whole, 1922 was a year of progress and of promise for the future.

MINING IN 1922

Copper Mining

Resumption of Mining Operations Increases Confidence—Labor Situation Shows Improvement—Costs Lower—Statistics of Production and Exports—Forecast

By H. A. C. Jenison
Geologist, U. S. Geological Survey, Washington, D. C.

IT BECAME APPARENT at the end of 1921 that new production could not reach the market until stocks were greatly diminished, and preparations were made for the resumption of operations. Anaconda resumed in January, the "porphyries" in late spring, and by midsummer almost all the important companies were operating. The new production, however, did not reach the market in quantity until July and August; and until then almost all sales and deliveries were made from stocks and foreign copper. The smelter production for the year averaged about 50 per cent of capacity, and the refinery production about 60 per cent.

Upon resumption of operations most companies found an adequate supply of unskilled labor, and wages were lower than when the shutdown occurred. By midsummer, however, a shortage of both skilled and unskilled workers developed. Wage increases were necessary to retain employees, but were insufficient to attract new men, and the labor shortage continued with slight relief due to the seasonal change of occupation. At the present time, with the exception of one or two small camps, the wages paid, although still considerably lower than on the war scale, are much higher than they were last spring. The supply of labor, particularly of skilled, is inadequate.

Throughout 1922 the cost of materials increased rapidly. The added expense, coupled with a market and labor shortage that prevented operations at full capacity, resulted in high cost of production. An effort has been made to offset these increases by selective mining, not successfully, but unfortunately necessary. Some companies, whose deposits are incapable of this expedient, operated at a loss.

The disadvantages, however, are balanced to a large extent by the present position of the industry, the most favorable since 1918. The following table indicates the change that has occurred. The statistics are of new copper only, and no attempt has been made to consider secondary copper:

New-Copper Statistics, 1921-1922

	1921, Pounds	1922, Pounds
Refinery production from domestic sources	609,000,000	897,000,000
Refinery production from foreign sources (including estimated imports of refined copper in year)	411,000,000	501,000,000
Stocks of new refined copper, Jan. 1	659,000,000	459,000,000
	1,679,000,000	1,857,000,000
Exports (including unrefined black blister and converter copper in bars and pigs, and refined in ingots, bars, and rods)	609,000,000	698,000,000
Stocks on hand, Dec. 31	459,000,000	277,000,000
	1,068,000,000	975,000,000
Total withdrawn and domestic account	611,000,000	882,000,000

In addition to new refined copper, about 112,000,000 lb. of secondary copper was produced, making a total production at the refineries of about 1,510,000,000 lb. The smelter production of copper was approximately 981,000,000 lb. Stocks of blister copper and materials in process of refining, in the hands of the smelters, in transit to refineries, and at refineries, on Dec. 31, 1922, were estimated at about 352,000,000 lb., compared with 283,000,000 lb. on Dec. 31, 1921.

The above estimates are compiled from the results of the first eleven months' operations, and from estimates for December, supplied by the smelters and refineries of the United States. The figures are interesting, but at variance with press and market opinions and reports. They indicate a great reduction of stocks, large imports, small refinery production from domestic sources, comparatively small withdrawals of new copper on domestic account, and larger exports than were anticipated a year ago.

An important occurrence in 1922 was the Anaconda Mining Co.'s acquisition of the American Brass Co. and the control of the Chile Copper Co. Anaconda's activities are regarded with interest.

The prospects for the immediate future of the industry are uncertain, on account of the impossibility of predicting the reaction of both producer and consumer to the present position. It is likely that there will be a temporary rise in price and an attempt to increase production. A material increase in price would be necessary to assure a reasonable profit for the industry, but it would result in a decrease in consumption. An effort will be made to increase production; if the selling price is high the effort will be all the greater. The industry is undoubtedly able to produce considerably more copper than can be marketed, and a large increase in production would probably result in keen competition for the market, decrease in price, and perhaps an increase in stocks. Such conditions would be hard on the industry, but would lead to ultimate good, as the result would be the elimination of that portion of the potential production which is high cost, is in excess of need, and which would become actual production under a high selling price. What amount the domestic market may require in the next two or three years is difficult to estimate; and unless European conditions, domestic transportation, and labor conditions improve, it is probable that the actual requirements will be appreciably smaller than are the potential ones at present.

The tendency toward a large increase in production, however, is apt to be balanced by the labor situation. The labor shortage will probably increase in the spring of 1923, and with restricted immigration it would seem that the industry must face a period of higher wages and, possibly, labor troubles.

Ultimately the future of the industry must be bright, but the convalescence is by no means complete; and, before it can enjoy pre-war prosperity, readjustments in the copper industry and in the world at large must be made.

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MINING IN 1922

Lead Mining

An Encouraging Record—Labor Efficiency—Effect of the Pittman Act on Lead Mining—Development Work—Mining and Milling Costs—Outlook for 1923

By Clinton H. Crane
President, St. Joseph Lead Co., 60 Wall St., New York

CONDITIONS DURING 1922 in the lead-mining industry in the United States were much more encouraging than in 1921. The wisdom of the major producers in continuing to operate during 1921, even though at an apparent loss, was more than justified. The improved morale of the working forces, from managers down, was in marked contrast to the disorganized condition of the camps that had closed, and, with the improving market, the whole industry was more prosperous.

The consuming demand began to exceed production in April. Stocks, which had been increasing for over twelve months, began to decline, being gradually liquidated until, by the end of the year, they were subnormal; yet the price of the metal rose from $4.70, New York, in March, at which figure it stood in December, 1921, to $7.25 in December, 1922. The enactment in September of a logical specific duty on the product of the cheap labor of Mexico probably did not effect any great curtailment of average imports, for the excess of demand over supply, seldom relatively large except during abnormally low domestic demand or unless inadequate tariffs unduly reduce the domestic output, must come from Mexico or elsewhere.

During 1921, and during at least the first half of 1922, efficiency had materially increased, partly due to the picked character of the men continuing in employment, and partly to the intensive effort of the operating heads to make both ends meet. By the fall of the year, all the available labor in the major lead districts (southeast Missouri, Idaho, Utah, and southwest Missouri) was employed. In general, the cost of living remained more or less stable, but at an average slightly below that of 1921; yet wages were increased in consonance with the advance in the price of lead. Labor is thus in a much better position than it was a year ago, and is probably more prosperous than it has been since the war.

Production in Utah, and to a lesser extent in Idaho, continued to be stimulated by the Pittman Act. This will expire during 1923, and there may be a coincident reaction in mining activity at that time, due to the inevitable drop in the price of silver. Correspondingly, during the last months of the application of the law, it is logical to expect feverish activity to obtain its benefits, which may considerably gouge the immediately available orebodies carrying high silver credits.

The lead output of southwest Missouri was much increased in 1922 by the general renewal of mining operations ensuing upon the advance in the price of zinc. On the other hand, the principal lead district, southeast Missouri, which accounted for about 40 per cent of the country's output, had no associated metals, and therefore, as always, depended for its prosperity entirely on the price of lead.

In all districts, the response of the mines to the renewed demand was hampered by the fact that development work, necessarily curtailed during the war, was still behind; this condition, however, is gradually improving. From a mechanical standpoint, nothing absolutely new was initiated, but possibly the principal feature was the further study and evolution of underground loading and haulage methods. Especially in the low-grade ore deposits of southeast Missouri it has become imperative to supplement with rugged and dependable loading machines such shoveling labor as can be obtained; and much successful experimental work has been undertaken in developing the type best suited to local conditions.

In the late fall of 1921 and during 1922, freight rates on ore and pig lead were revised downward from the excessive peak reached in August, 1920; but freight costs today are still about double those of pre-war years.

Throughout the country, lead mining and milling costs increased approximately 25 to 40 per cent from December, 1921, to December, 1922, the decrease effected in the preceding year being already partly offset; yet probably in no case were the abnormal costs of 1920 even closely approached. The following table gives the variation in chief cost items for the three principal districts, in each case for the last month of 1920, 1921, and 1922, the figures being expressed in percentages of those for December, 1920:

Variation in Costs, December, 1920, 1921, 1922

	Southeast Missouri			Idaho			Utah		
	Dec., 1920	Dec., 1921	Dec., 1922	Dec., 1920	Dec., 1921	Dec., 1922	Dec., 1920	Dec., 1921	Dec., 1922
Base wage	100	66	80	100	81	94	100	78	78
Coal	100	81	65	[illegible]	93	83	100	78	94
Coke	100	63	87	100	100	94	100	94	94
Powder	100	96	8[illegible]	100	89	79	100	89	79
Drill steel	100	83	[illegible]2	100	95	89	100	90	92

For coal and coke, the percentages for December, 1922, are somewhat misleading, the coal strike having caused excessive prices in the latter half of the year. To maintain operations during the summer, some companies resorted to oil-burning in their power plants.

Major items of new construction are the remodeling of the Morning mill, at Mullan, Idaho, and the enlargement of the central power station of the St. Joseph Lead Co., at Rivermines, Mo.

For 1923 the outlook for the lead-producing industry is distinctly encouraging. If there be no repetition of last year's disastrous coal and railway strikes, and unless there occur an unanticipated reaction in the general upward trend of the country's business, the demand for the metal should continue strong. Nothing in the present situation points to any appreciable decrease in the paint, storage-battery, and lead-covered cable industries, and these alone account for 70 per cent of the lead consumed in the United States.

MINING IN 1922

Zinc Mining

Production and Requirements—War and Peace-Time Demands—Present Mining Conditions in the United States—The Recovery of the Industry

By Arthur Thacher
Consulting Engineer, 900 Security Building, St. Louis, Mo.

IN THE FOUR YEARS prior to the Great War the world produced 4,000,000 tons of zinc. Between and including 1915 and 1918, 4,000,000 tons was produced. In the four years since the war (1919 to 1922), the production will prove to have been a little less than 3,000,000 tons. If 1,500,000 tons is assumed as the amount withdrawn for war purposes, it would seem that 2,500,000 tons was used during the war period for industrial purposes. If it is assumed that a little over 1,000,000 tons has been returned from war supplies—as zinc, brass, and scrap—the amount absorbed for industrial uses since the war would be 4,000,000 tons.

Zinc for Industrial and War Purposes

Many will object to an estimate of 1,500,000 tons for war purposes, maintaining that the amount should be much greater. However, if it is realized that the United States used for industrial purposes, during the war period, 1,400,000 tons—almost the same amount as in the preceding four years—only 1,100,000 is left for the remainder of the world; and this seems little enough, as it is only 40 per cent of pre-war requirements. If a higher estimate of the amount withdrawn for war purposes is made, it would mean that a larger amount would be returned from war supplies, and would thus indicate a greater consumption since the armistice.

The consumption of zinc before the war increased at the rate of about 8 per cent per annum, and there was no reason to expect a diminution for several years. If the war had not occurred, the present consumption probably would have been about 1,700,000 tons annually. Since the war, the consumption in this country has increased about 15 per cent, whereas the remainder of the world has managed with about 8 per cent less than in pre-war times. Our visible stock, as well as that in the consumers' hands, has been exhausted; and we are calling for an increased amount over that needed in pre-war days. As indicated above, the industrial consumption was restricted during the war, but this condition was only temporary, and the demand should now increase at a faster rate than it did before the war.

Where will the zinc for this increasing demand be obtained? Conditions have changed since the armistice; fuel, transportation, and labor have advanced in price. In foreign countries, output is not back to the pre-war average, and it will be some time before an increase will occur. The results clearly point to the fact that our production will have to be augmented, not only to take care of domestic requirements but for export to the remainder of the world.

Although the United States was not affected as seriously by the war as were other nations, many changed conditions must be faced. Before the war, the price of zinc ore in Joplin was about $14 per ton below the value of the recoverable zinc, an amount that represented the cost of smelting. In 1915 and 1916 the difference rose to about $58, and hastened the acquisition of increased smelting facilities; new plants were constructed and old and obsolete plants were rehabilitated and their capacity was more than doubled. The inevitable reaction ensued, and in 1917 the difference fell to about $19; in the four years since the armistice it has averaged about $26. Of course, the increased expense for fuel, labor, and supplies probably makes the profits no greater than in pre-war days; and, for the near future, existing smelting charges are likely to be maintained. This indicates a lower value for high-grade Joplin ores of about $12 per ton; or, stated in other words, zinc would have to be about 1.2c. per pound higher to make the ore of the same value to the miner as it was in pre-war days. This applies only to high-grade Joplin ores. As the cost of smelting is based on the ton of ore, the charge on low-grade ores would rise rapidly. The high quotations for zinc in 1915 and 1916—about 14c. per pound—caused a tremendous boom in zinc mining; and, in spite of the high smelting cost, exceedingly low-grade ores were shipped from the Far West. These were slow in reaching the smelters, and, in the years 1916 and 1917 there was a production of about 1,350,000 tons.

Present mining conditions in the United States show that, aside from the Anaconda Copper and New Jersey Zinc companies, with their high-grade metal, we must depend mainly on Joplin. The West, with its low-grade ores, is burdened with increased smelting cost; the expense for transportation, labor, and supplies has advanced, and the region will be slow in getting back even its pre-war rates. Many of the mines cannot produce ores of such low grade as they did under pre-war conditions. The Joplin or Tri-state district has a great future, from which a considerably increased production can be expected; but prices will have to advance. A limited supply of ore was produced there at the low figure of $20 per ton, but only by taking the richer ores and neglecting development work.

Industry Can Face Future With Confidence

The period of greatest depression has passed; the industry is on the road to rapid recovery. How rapid this has been recently will be appreciated if data for the low months of 1921, both as to production and price of zinc, are compared with present figures. The production has been more than doubled, and prices have materially advanced. In 1922 the coal and rail strikes delayed progress, so that the great advance occurred in the latter part of the year. In fact, the recovery could scarcely have been more rapid without causing serious economic derangements. One can anticipate continued progress in the future, but it will be well if this is not so rapid as to bring about runaway conditions.

MINING IN 1922

Gold and Silver Mining

Revolution in the Transvaal—Gold Production in Canada and the United States—Alaska Juneau—Need for Economy in Use of Gold —Silver Production in 1922—Mining in Mexico—United Comstock

BY SIDNEY J. JENNINGS
Vice-President, U. S. Smelting, Refining & Mining Exploration Co.,
120 Broadway, New York

THE OUTSTANDING EVENT in gold mining in 1922 was the attempted revolution in the Transvaal. In 1921, the Transvaal produced $167,701,000—51 per cent of the estimated world's production—much of which depended upon the premium. The leaders of the industry there were insistent in showing that many of the mines could not produce gold without loss when this premium disappeared; they pointed out the impossibility of complying with the demands of the unionized mine workers, of meeting government taxes and the high cost of materials, and of continuing operations. In spite of these warnings, the demands of the labor unions continued, which culminated in a disastrous labor upheaval. The strike started on Jan. 10, 1922. The radical element gained control, and a general strike throughout South Africa was declared by the Augmented Executives of the South African Industrial Federation, to take effect on March 2. This developed into a rebellion, which was suppressed by force of arms, resulting in a large number of casualties. On March 17 the strike was declared off, and the men resumed work on the terms offered by the Chamber of Mines.

The strike was caused in the first instance by the refusal of the leaders of the men to face facts and to agree to a reduction in wages and a change in working conditions that would make it possible for the low-grade mines to continue operations when the currency price of gold was well under 100s. per ounce. Some of the leaders of the men, perhaps the majority, also wished to further schemes designed to transfer effective control of the mines to the workers.

The result of the strike on the output of gold was such that during January, February and March only 639,723 oz. was produced, the output gradually increasing to 776,000 oz. in October. Costs were reduced from an average of 25s. 8d. per ton in 1921 to 22s. 10d. in June, 1922, and further reductions have since been made. The effect of this on the life of the producing companies has been summarized by Sir Evelyn Wallers, who stated that, at the average cost obtaining in 1921, 25s. 8d. per ton, an estimated reserve of 316,000,000 tons of ore was available, which at the average rate of production would last a little over thirteen years. At the pre-war costs, of 17s. per ton, the amount would be increased to 544,000,000 tons, which at the same rate would last a little over twenty-two years. In addition to the ore reserves of the present producing companies, other known deposits would probably be brought within the economic limit by the pressure of necessity and this would induce still lower working costs.

The estimated output of the Transvaal for 1922 is $144,000,000, a reduction of $23,700,000 from that of 1921.

In 1921, Canada produced $19,105,000 worth of gold, an increase of $3,250,000 over the previous year, due to the activities of the mines in the Porcupine district; 1922 will probably show a further increase over 1921. The output from the United States in 1922 will not differ materially from that of 1921—$48,094,000, although renewed interest in the production of gold has been shown. No new finds of importance have been reported, but operations on some properties that were shut down owing to high wages and high cost of supplies have been resumed.

The demands of the labor unions in Australasia and the high costs of supplies forced the suspension of operation at several mines producing gold; in consequence, a small reduction in the total output of gold in 1922 is probable. The output from India in 1922 will not vary greatly from that of the previous year. The estimated total production of the world for 1922 lies between $305,000,000 and $310,000,000.

The steady decline in the world's production of gold during the last ten years, with the exception of 1915 and 1916, is a source of concern, not only to gold miners but to economists. In 1912, the gold production of the world amounted to $474,322,664. The amount estimated for 1922 shows a reduction of about 33 per cent of this. There does not appear to be any new field that will supply a large new production. Canada, however, with its unexplored territories, offers possibilities. In default of new fields of medium-grade ore, it behooves the mining engineer and the metallurgist to devise means for working at a profit the large deposits of ore of 3 dwt. per ton or less that are known to exist in many parts of the world.

The outstanding achievement during the last year in this direction is the result obtained by the Alaska Juneau Gold Mining Co. in working the gold-bearing schists on the mainland behind Juneau. During 1922 the results obtained indicate that the turning point has arrived, a profit, though small—from the stockholders' point of view as yet inadequate, but which from the operators' point of view is promising—has been achieved.

If the decline in the production of gold continued for another ten years at the rate that has obtained during the last ten years, two things will probably happen: the value of commodities as measured in gold will decline greatly, and a new and vigorous attempt will be made to change the standard of value from a gold basis. It therefore behooves the gold miner to search diligently for new supplies of ore, and the gold user to be more economical. In this connection it is of interest to note that of the $16,000,000,000 worth of gold estimated to have been produced since records were kept, almost half has been utilized in the arts or has been destroyed. From 1890 to 1910, $6,000,000,000 worth of gold was produced, of which $2,000,000,000 was used in manufacturing. A certain amount of this can be re-

covered for monetary use in times of stress. There is, however, a large amount used in cheap jewelry, gold leaf, and dental work, which cannot be recovered. It is in this direction that economy in the use of gold can be practiced.

Silver Mining

Estimates indicate that the four countries which contributed 85 per cent of the world's supply of silver in 1920 and 1921 produced the following amounts in 1922:

	Ounces
Mexico	77,111,000
United States	55,000,000
Canada	16,422,000
Peru	9,264,000
Total	157,797,000

On the assumption that the proportion (85 per cent) was maintained in 1922, the total production for the world would amount to 185,643,000 oz. It seems unlikely that the stimulus that increased production in 1922 in the four countries mentioned was sufficiently widely diffused to increase the production in other countries in equal ratio. I therefore estimate the production of the world for 1922 at 180,000,000 oz., the largest since 1918.

The Mexican government in 1922 continued to maintain order throughout its territories, and this induced the resumption of mining. The favorable price for silver early in the year stimulated an increased production from those mines that were already operating. The good rainfall replenished the water storage of the power companies, and allowed them to supply the requirements of the silver mines. Although strikes of skilled workmen occurred in some camps, the firmness and fair dealing of the management, assisted by the local governments, prevented any outbreak of importance. The production of Mexico for 1922 will prove to be the largest since 1912. The outlook for the continued prosperity of silver mining in Mexico is excellent.

In the United States, the output in 1922 increased 1,300,000 oz. over that of 1921, only 2.4 per cent, whereas the Mexican output increased by 19.3 per cent. In the United States, the output was swelled by the silver produced by a large number of copper companies, which resumed operation on April 1. The price of $1 per ounce, fixed by the Pittman Act, stimulated production. After the purchases under the Pittman Act up till Dec. 16, 1922, there remained about 62,077,000 oz. still to be purchased. At the average rate indicated for the last few months this will be completed by Jan. 1, 1924.

The United Comstock company erected in 1922 a mill with a capacity of 2,500 tons per day. The ore will average between $5 and $6 in gold and silver. This in a courageous and skillful attempt to apply modern mining and metallurgical methods to the low-grade portion of a well-known deposit, the high-grade ore of which had already been mined. New discoveries have been made in the Tonopah district, Nevada, and also at Randsburg, California. However, the general outlook for the continued increase in the production of silver in the United States is not good.

In Canada, the increase of the production of silver in 1922 compared with 1921 was 3,420,000 oz., or 26.3 per cent. The Premier Mine, in British Columbia, has contributed materially to the increase. In Keno Hill, in the Yukon territory, high-grade silver-lead ore has been opened up, containing from 200 to 500 oz. silver per ton.

Radium, Uranium, and Vanadium

By Frank L. Hess
Geologist, U. S. Geological Survey, Washington, D. C.

THE PRODUCING COMPANIES carried such large stocks—a few thimblefuls apiece—of radium that they sold much of their product in 1921 for prices that did not allow a proper profit, and started 1922 with poor sales and probably between $1,000,000 and $2,000,000 tied up in stock. In September, 1922, one gram of radium was sold to the Province of Quebec for a reported price of $77,000, which was very low at the time; but directly afterward it became known that the deposits at Luiwishi and Kasolo, Belgian Kongo, were furnishing many tons of rich ore, carrying pitchblende and its alteration minerals, and that two American companies were acting as agents and offering radium at $70 per milligram. Reports give the content of U_3O_8 as 50 to 70 per cent—a staggering figure when compared with 2 per cent ore from Colorado and Utah. This was the last straw for the Colorado carnotite mines, and all operations there then ceased.

During 1922, some pitchblende was mined in Cornwall, some autunite and torbernite in Portugal for French use, and the pitchblende mines in Czechoslovakia (Bohemia) are thought to have run as usual. The output of radium in this country during 1922 was about 13.5 grams of the element (Ra). Foreign production may have reached 8 grams. Radium prices seem to have hit bottom at $70 per milligram.

After long investigation, the General Electric Co. isolated elemental uranium, and has been experimenting with it in Röntgen (X-Ray) tubes, for which its high atomic weight (238) promises some advantage, but the process of reduction is elaborate and costly.

Vanadium produced in the United States since the Vanadium Corporation of America acquired the Primos Chemical company's roscoelite deposits in Colorado has been only as a byproduct of radium isolation, and, therefore, the amount was small in 1922, probably less than 100 tons. The Vanadium Corporation still holds the main supply of vanadium in Peru, but it has such large stocks of ore on hand that because of the poor market in 1922 it was unnecessary to operate the mine.

Africa has also offered competition in vanadium. Mottramite, a copper-lead vanadate, has been shipped from the vicinity of Tsumeb, in Southwest Africa. The Otavi Exploration Syndicate, Ltd., shipped about 1,200 long tons in 1922 up till Dec. 1, and was shipping at the rate of 50 tons a month on a contract expiring in October, 1924. The content of vanadium is unknown, but is probably less than 8 per cent V. At Broken Hill, Northern Rhodesia, lead vanadates have been known for some time. In June, 1922, the Rhodesia Broken Hill Development company reported 7,617 tons of ore averaging 5.9 per cent V_2O_5 (3.3 per cent V) on the mine dump and at the smelters.[1] This grade and quantity of ore will require careful and economical working to make the production of vanadium profitable.

Vanadium in ferrovanadium has sold at about $3.50 per pound for the contained vanadium. Except for the lead vanadates mentioned, there has been no market for ore.

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[1] Imperial Inst. (Great Britain), "Mineral Resources of Northern Rhodesia," Bull. 3, Vol. 20, 1922.

MINING IN 1922

Iron Mining

Conditions in the Lake Superior Region—Labor Shortage—Amalgamation of Producers—Metallurgical Advance —Economies Effected—Recent Developments

By Dwight E. Woodbridge
Consulting Engineer, Sellwood Building, Duluth, Minn.

IRON MINING CONDITIONS in the Lake Superior district improved steadily during 1922. The shipments of the season aggregated over 43,000,000 tons (42,613,184 tons by water, exclusive of rail movement to furnaces), or 63 per cent of the maximum. Ore on hand at lower Lake docks amounts about to the same as it did a year ago; but the stock is being depleted at a greater rate, and the indications are that, by the opening of navigation in 1923, there will be little in reserve.

Activity is evident in mining, but it is limited by a shortage of labor; the restrictions on immigration affect it seriously. It is expected that the demand for ore in 1923 will be considerably greater than it was in 1922; much stripping and underground development is under way, in an effort to prepare the mines for increased production. Ore prices for 1923 will probably show an increase.

Bethlehem's recent acquisition of Lackawanna and Midvale will serve to concentrate under one control a tonnage of ore that is second only to that of the Steel Corporation. Lake ore holdings of Bethlehem were small before this absorption occurred; it depended on foreign ores, which it holds in quantity. But now it owns, in addition to former Lake supplies, all or part of a larger number of other deposits. In about a one-fifth interest in the Mesabi Iron Co. it has a reserve the worth and quantity of which is far greater than all its other Lake holdings combined.

Since the introduction, in the treatment of Mesabi ore, of washing the sandy material, this manner of beneficiation has grown, until ore of this character now comprises 10 per cent of the total shipments from the range. About eighteen washeries are operating on the Mesabi and two on the Cuyuna, with a yearly output capacity of more than 10,000,000 tons of concentrate, which is nearly 25 per cent of the total amount shipped in 1922.

In the fall of 1922, the plant of the Mesabi Iron Co. was started. It was designed to beneficiate the hard magnetic taconites that exist in such large quantities on the eastern part of the Mesabi. The work of the year has proved that these can be crushed, ground to powder, separated from the gangue, and sintered into a high-grade and desirable furnace material at a comparatively low cost.

However, economic operation depends on tonnage; and the Mesabi company will probably soon increase its output many fold. It will in time become one of the notable producers of high-grade ore, with an almost indefinite life. On account of the delays incident to a beginning of operations in a new class of mining enterprise, Lake shipments from its works amounted to only about 10,000 tons during 1922. It is planned to enlarge the plant at Babbitt.

In 1922, many iron mines were abandoned. The Crosby, Woodbridge, Pilot, Meadow, Sliver, and Ordean mines are exhausted, and reverted to private parties or to the state. The Hill-Walker mine, in the Great Northern group, recently taken over by the Orwell Mining Co. (Tod-Stambaugh Co. and Inland Steel Co.) was one of the abandoned properties; but it contained about 10,000,000 tons of ore, not high-grade, but capable of beneficiation. On the Cuyuna, a number of mines, chiefly underground and manganiferous, have been dropped by their lessees; others have been purchased. Of the 230 mines on the Mesabi and Cuyuna ranges that have shipped iron ore in quantity, not fewer than 70 have been abandoned, and nearly all of these have been exhausted.

There are no new discoveries to record in the Lake Superior region. Two or three promising small leads have been struck, and these may develop into mines. Reclamation of lean ores and greater depths of development seem the only means of increasing output. Apart from the magnetites of the Mesabi Iron type, the promise for the future lies in deep-seated deposits the upper areas above which are already well known and for the most part are now under operation. The Gogebic Range is the best exemplification of this; the Marquette, the second. On the former, two shafts, now starting, will be bottomed at not less than 4,000 ft. One is the Royal, of the Oliver Mining Co.; the other, the Eureka, of Ogleby, Norton & Co. Both are to open lower levels on the great pitching troughs of that district. There is no information available as to what such shafts may add to the reserves; but it is improbable that anyone would drive such a shaft as the Royal —set far back in the footwall, lined with sets of copper-steel, equipped magnificently, thoroughly electrified—unless there was an assurance of considerable production for many years.

In the vicinity of Michigamme Mountain, Michigan, the Ford Motor Co. has begun the exploration of the property bought in 1921 from the Michigan Land & Iron Co. There is a considerable area in which ore may exist. The Ford company has been mining at its Imperial property during the year, and has thus secured much ore.

A large quantity of Cuyuna manganiferous ore was sold in 1922, obtained from large open-pit mines; the underground manganiferous properties have had no chance to do much. The siliceous ores, containing from 38 to 40 per cent iron and about 37 per cent silica, were in great demand in 1922; from the Vermilion Range, about 100,000 tons was shipped. These ores exist in quantity in the Cascade and Felch sections of Michigan, and it is probable that the bulk of the demand will be met from there, particularly in view of the freight differential.

MINING IN 1922

Petroleum

The Price Situation—History of the Industry in 1922—Development for the Year—Outlook for 1923

By John D. Northrop
Assistant Chief, Land Classification Board, U. S. Geological Survey, Washington, D. C.

THE YEAR 1922 will doubtless be recorded in the annals of the domestic petroleum industry as a significant one, although the events for which it is noteworthy did not characterize it as a particularly satisfactory one from the point of view of the oil producer, the oil purchaser, or the oil refiner. Overproduction and a debilitated market—the bane of those who supply basic commodities in every industry—account broadly for the woes of all concerned. To the pipe-line companies, however, overproduction assured a busy and highly satisfactory year. From the viewpoint of the ultimate consumer, the diminished prices and large reserves of gasoline and lubricants were satisfactory.

Recent History of the Industry

For the producer of crude petroleum, with whom this discussion is chiefly concerned, 1922 opened with a market that was sound as to prices, but one that involved elements of immediate weakness and of ultimate strength. Domestic production was increasing steadily. Consumption was manifesting symptoms of satiation, and stocks of domestic and Mexican oils were mounting rapidly. The knell of the light-oil industry in Mexico had been sounded, but imports of crude oil from that country were still increasing. The full measure of the Mexia, Texas, Haynesville, Louisiana, and El Dorado, Arkansas, fields, opened in 1921, had not been taken. Burbank, Oklahoma, was in the ascendant, with ample evidence of large productive capacity and little indication of areal limit; and other districts in Oklahoma and northern Texas were giving promise of sustained or increased yield from deep sands.

With sound conditions in the petroleum industry, with a general revival in business, with greater exports, and with an unprecedented rate of increase in the demand for oil products in the automotive industry, the oil producer, being an optimist by nature, felt justified in taking chances. In this frame of mind he elected to go ahead with routine development and exploration as usual, despite a 75c. break in the market for high-grade eastern oils before the middle of January, 1922, which he interpreted as a reflection of local rather than of general conditions, ascribing it more to the congestion of imported oil at Atlantic seaboard storage points than to the threat of overproduction in Oklahoma and Texas. In the failure of Mid-Continent and western quotations to follow this retrogressive movement, and in the 25c. advance of Appalachian grades early in June, the operators of the West and Southwest found apparent indorsement of their business-as-usual policy, and continued field activity accordingly.

As a consequence of the success resulting, country-wide production, supplemented by current imports, already aggregating about 4,000,000 bbl. per month in excess of current consumption, increased rapidly during the first half of 1922, to an average monthly surplus of 10,000,000 bbl., overtaxing the facilities for storage, inundating the purchasing agencies, and eventually depressing the market. The collapse came in the latter half of July. It was general as far as the light-oil fields of the country were concerned. The reductions it effected in the prices of representative grades of crude oil were as follows: Pennsylvania, from $3.50 to $3 per barrel; Lima-Indiana, from $2.48 to $1.98; Oklahoma-Kansas-North Texas, from $2 to $1.25; and Salt Creek-Wyoming, from $1.40 to 70c. per barrel. In California, where quotations are based on specific gravity, a general reduction of 50c. per barrel was effected. Gulf Coast oils sustained the shock without reduction, due chiefly to the fact that they are essentially fuel oils, that their market is mainly on the Atlantic seaboard and not in conflict with that for Mid-Continent refinery residuums, and that they are needed in that market to supplement the diminishing supply from Mexico.

At the end of 1922 the outlook of the oil producer in the United States was appreciably brighter than it was twelve months before. Except for the Smackover district, in Arkansas, the sources of flush production that demoralized conditions in 1922 are sufficiently defined to cause little apprehension as to their future course. Production generally is under reasonable control; and, except as noted, is not menaced by the prospective output of fields discovered during the year.

Consumption and Prospects

Domestic consumption of petroleum and its products increased enormously in 1922. Exports gained substantially. Imports fell off in the latter half of the year, and water shipments of California fuel oil to the Atlantic seaboard began. The elimination of Mexico as a menace became an accomplished fact. Pipe-line and storage facilities and refinery capacity have been increased, and the market for Mid-Continent production is now on a specific-gravity basis, which affords the oil purchaser a logical means of encouraging the production of needed grades of oil and of discouraging the production of grades for which there is no immediate market. These factors are straws that indicate an unmistakable drift in the undercurrents of the crude-oil situation toward material improvement in 1923.

U. S. Geological Survey statistics for the first eleven months of 1922 indicate that the production of crude petroleum in the United States in that year amounted to not less than 550,000,000 bbl., and exceeded the former record output, attained in 1921, by more than 77,000,000 bbl., or nearly 17 per cent.

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MINING IN 1922

Asbestos

By Samuel H. Dolbear
Consulting Engineer, Thetford Mines, Province of Quebec, Canada

AT THE BEGINNING of 1922 most of the operators in the Canadian asbestos fields had large stocks of fiber on hand. Many of the mills were closed during the first five or six months of the year, and only two or three mines operated full time. Several companies ran for only four days per week throughout the year. By July, the stocks had diminished, and a fairly brisk demand for the shorter grades followed, attributed to an expansion in building operations in the United States. Improvement in demand for the longer grades occurred during the latter part of 1922, this being limited chiefly to spinning fiber.

The Johns-Manville Co. built a new mill at Asbestos, Que., to replace older equipment. It has an estimated capacity of about 250 tons per hour. The company also acquired an option on the property of the Bennett Martin Asbestos & Chrome Mines, Ltd., with mills at Thetford Mines and at Coleraine. The purchase price is reported to be $2,750,000. The Asbestos Corporation of Canada appropriated $500,000 for the erection of a new plant, to be built early this year. The mill of the Asbestos Mines company, at East Broughton, was destroyed by fire in December of 1922.

Most of the larger mills were in operation at the close of 1922, some on part time. The milling capacity of the Canadian fields was increased substantially during the war, so that possible output in the next few years will probably exceed the demand. Some of the smaller mills in outlying districts may not be able to compete at reduced prices.

The post-war depression was felt severely in South Africa and Rhodesia in 1922, although the demand for crude asbestos revived during the latter part of the summer. Some Russian fiber appeared in the United States, believed to have been shipped from stocks on hand at the time of the revolution. No activity was reported in the Arizona asbestos districts during 1922, and no important development occurred in other American fields. Prices sagged from month to month on all of the longer grades, although the market for paper, cement, and to some extent for shingle stocks showed decided firmness, with occasional gains in prices.

Antimony

By H. K. Masters
Mining Engineer, Wah Chang Trading Corporation, Woolworth Building, New York

ANTIMONY MINING continues to suffer from the post-war depression that paralyzed all mining. The stimulation of the war demand, which raised the price of antimony from 7 to 45c. per pound, brought about an overproduction, leaving, when the war ceased, heavy stocks in the hands of everyone interested in the industry, from miner to consumer. During the war, at least twelve countries were mining antimonial ores to the full extent of their productive capacity under war conditions. The total reported production rose as high as 80,000 tons in 1916, compared with a pre-war average of 24,000 tons. China produced over 40,000 tons. Today, with the metal priced at below 4½c. per pound in bond, New York, or, say, £22 per ton, c.i.f. Europe, only one country, China, can mine antimony at a profit. Just before the war, China was producing between 50 and 60 per cent of the world's supply, principally from the rich deposits in the province of Hunan, which are yielding 90 per cent, possibly more, of the ore now being mined in the world for its antimony content, present production being at the rate of about 9,000 tons per annum. A small production continues in France, Algiers, and Australia; and we heard recently of Austrian metal in Germany; but until the demand for the virgin metal becomes normal again, in consequence of the exhaustion of war-scrap, and until the price responds to renewed demand, the antimony-mining industry will continue to stagnate. Even when the stocks of old materials are gone—and 1923 should see their complete exhaustion—China will undoubtedly retain her predominant position as the world's principal producer.

The stocks of virgin metal in the world—visible and invisible—are not abnormal, and the consumption is steadily growing. A constantly increasing amount is being absorbed in the manufacture of soft alloys and in the rubber, enameling, and chemical trades. The outlook is distinctly better than it was this time last year.

Feldspar

By Raymond B. Ladoo
Mineral Technologist, U. S. Bureau of Mines, Washington, D. C.

THE FELDSPAR INDUSTRY did not suffer as greatly as did some other industries from the depression of 1921. At the beginning of 1922 the demand was fairly good for all grades, continuing so until June. During the summer it declined in consequence of the customary slackening of work in the pottery and glass industries. In addition, embargoes, due to the coal and railroad strikes, hindered shipments. A strike in the pottery industry further lowered the demand during the latter part of the year. Prices throughout 1922 continued about the same as at the beginning of the year, but some cutting was evident. The recent prices of crude spar in relation to the prices of ground spar are higher than before the war.

A new feldspar mill was built at Keene, N. H., in 1922, utilizing the principle of continual grinding and air separation. Another, erected at Cleveland, Ohio, for Canadian spar, uses the principle of continuous grinding, and sizing by means of vibrating screens. A large mill at Erwin, Tenn., was converted to use a process of wet grinding and water classification. Another, also at Erwin, discarded intermittent grinding in favor of continuous grinding and air separation. Considerable activity occurred in the Connecticut fields in the latter part of 1922. A new mill was built south of Middletown, and was ready for operation at the end of the year.

Interest in Canadian feldspar continued throughout the year. The production for the first half of 1922 was 13,255 tons, valued at $110,789, or about the same as for the corresponding period in 1921. The exports, principally to the United States, for the first half of 1922 aggregated 11,706 tons, valued at $82,556, as against 16,215 tons, valued at $102,160, for the corresponding period of 1921.

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MINING IN 1922

Diatomaceous Earth

By Norris Goodwin
Consulting Chemist, 606 Pacific Finance Building, Los Angeles, Calif.

A STEADILY INCREASING demand for diatomaceous-earth products was witnessed in 1922. All the consuming industries have shown a return to normal conditions; consequently, the market has prospered. Reliable production data are not yet available, but it seems probable that the year's output will exceed 60,000 tons. California is still the leading producer. There has been little change from the market prices at the beginning of 1922.

Several new producers have entered the field. The most important development has occurred at Covina, Los Angeles County, Calif., where insulating brick and light-weight building products are being manufactured.

Much research work has been done on the use of diatomaceous earth as a filter aid; and several important articles bearing on this phase of the industry appeared in 1922. At present, the sugar industry consumes the major portion of the diatomaceous earth produced. In the field of heat insulation, there is marked tendency to discard sawed brick and block, and to substitute preshrunk, kiln-burned brick, three producers of which are now marketing their products in the United States.

The use of diatomaceous-earth products in the building industry advanced considerably during 1922. The powdered material has been extensively used as a sound deadener in walls, and in ceilings for heat insulation. Light-weight partition tile have been manufactured and give promise of developing a considerable outlet for diatomaceous earth.

Barytes

By James B. Pierce, Jr.
Chief Chemist, Rollin Chemical Corporation, South Charleston, W. Va.

THE YEAR 1922 recorded a decided improvement in market conditions for barytes, both crude and prepared. It is estimated that 40,000 to 50,000 tons was mined in the Cartersville field, Georgia, and from 10,000 to 15,000 tons in the Sweetwater field, Tennessee, during the year, as compared with 25,000 and 8,000 tons, respectively, in 1921. The production of the Missouri field will undoubtedly show an increase, probably in about the same proportion.

The Fordney-McCumber Tariff Act gave the industry a decided boost in the last quarter of the year; this should be carried forward through 1923; in fact, until there is no other tariff legislation to cause unsettlement.

Unfortunately, the quality of the barytes produced did not improve; this is especially true in regard to the "crude-washed" grade, largely used by barium-product and lithopone manufacturers. In consequence, many of the leading users operated their own mines and acquired further properties to insure an adequate supply in the future. Unless the producers improve their methods of washing, so as to be able to market a high-grade crude, only a small market will be available; to protect themselves, the principal manufacturers will have to become miners and preparers of barytes, even as the manufacturers of ground and water-floated grade have had to mine their own ore.

Molybdenum

By John D. Cutter
Vice-President and Metallurgist, Climax Molybdenum Co., New York

THE year 1922 did not witness the resumption of the mining of molybdenum on a large scale; nevertheless, considerable advance has been made in its use. The large stocks that accumulated during the latter years of the war have not yet been exhausted, in spite of a rapidly increasing consumption.

Molybdenum steels have continued to gain popularity among motor-car manufacturers, a popularity based as much on the comparative ease with which they can be fabricated and the consequent low shop costs as upon the high quality obtainable in the finished parts. The large supply of molybdenum in this country, and the fact that it is the only constituent of alloy steel available in such quantity, are also responsible for its wider adoption.

Molybdenum steels have found wide favor apart from the automotive industry. The general efficiency of the alloy has been responsible for its spread into fields hitherto denied to alloy steels. In the agricultural-implement industry it has been used for shovels, plows, and scrapers; in the mining industry, molybdenum steel balls in ore-grinding mills have shown an extraordinarily long life, and molybdenum steel is proving its value for use in the manufacture of elevator buckets. Perhaps the most impressive development of 1922, aside from the increased use of molybdenum steels in the automotive industry, has been the growth in the use of mill rolls containing molybdenum, because of the large amount of steel that can be handled without redressing the rolls.

An exhibit of molybdenum steels was made at the International Steel Exposition, which was held by the American Society for Steel Treating, at Detroit, during October of 1922. It was demonstrated that the efficient limit of molybdenum in alloy steels continues to be low, always less than 1 per cent and usually less than 0.5 per cent. It was also shown that the promise of 1921 was fulfilled during 1922, and that molybdenum had already assumed an established place in the steel industry—one that is destined to show a healthy growth during the next few years.

Borax

By F. M. Smith
President, West End Chemical Co., Oakland, Calif.

AT THE close of 1922 there appeared to be considerable improvement in the demand for borax and boric acid. In consequence, more activity was noticeable in the mining of borate ore. Although conditions in this country are improving, requirements are still far from normal. Prospects, however, indicate a continually increasing consumption. Conditions in Europe being still unsettled, the amount exported is small.

Aside from the installation of calcining equipment at Las Vegas, Clark County, Nev., to handle the ore from the deposit owned by the West End Chemical Co., no developments of note have occurred in this industry during 1922.

Magnesite

BY GEORGE J. YOUNG
Associate Editor, San Francisco

MAGNESITE PRODUCERS passed 1922 in uncertainty. The Tariff Act cleared the air, although the domestic producers were assured of nothing more than a market that would be dominated by keen competition. There was a slump in September, due to a glut in the market. Imported dead-burned magnesite sold in August at $22 per ton on the Atlantic seaboard. In December, the price had risen to $43.50 per ton at Baltimore—an increase of $17.50 per ton, which was greater than the tariff differential of $11.25 per ton on dead-burned and grain magnesite. Domestic producers in California and Washington are asking the railroads for lower freight rates to Chicago, the present rate from California being $15 per ton. Shipment by the Panama Canal can be made for slightly less. Any reduction will help the producers, and is highly desirable.

The Northwest Magnesite Co. produced no magnesite in 1922; but in December some men were put to work to recondition the plant; the Cottrell plant at the Northpoint smelter was purchased and installed at Chewelah during the year. The plant resumed operations early in 1923. The American Mineral Products Co. made a small production. The Western Materials Co., so far as is known, made no production. Eight or more companies in California produced plastic and dead-burned magnesite of an equivalent to approximately 65,000 tons of crude magnesite, only a relatively small amount of which was marketed as dead-burned magnesite and shipped to Pittsburgh.

Phosphate Rock

BY H. D. RUHM
Chemical and Mining Engineer, 135 Liberty St., New York

FOLLOWING the abnormal activity in the phosphate-rock industry in 1920, there was little or nothing doing in 1921. Buyers of rock had covered requirements during the fall of 1920 by anticipating a business in the following spring of even larger proportions than was in evidence in 1920. When actual business proved to be less than half of that of 1920, and when the demand in the spring of 1922 was only a little greater than that in 1921, with an export demand that was less, on account of the exchange situation, the effect was to curtail mining operations to a minimum. Consequently, production was almost entirely confined to those fertilizer companies that operated their own mines, to maintain the organization intact where this was essential. The small amount of mining outside this field was almost entirely confined to meet the needs of producers of phosphoric acid and for the blast-furnace production of ferrophosphorus. One or two large companies took advantage of the lull to put their plants in order; and one concern, the American Agricultural Chemical Co., began the construction of a railroad and a plant to develop its recently purchased properties in Tennessee.

Several mining companies in Florida and Tennessee were forced into liquidation and went out of business. Some of them are now in process of reorganization, or the properties are being developed by new concerns.

Quicksilver

BY H. W. GOULD
Mining Engineer, 524 Kohl Building, San Francisco

QUICKSILVER mining in the United States showed little change in 1922 compared with 1921. With the exception of that of 1921, the output will probably be the smallest since 1850, exceeding the 1921 production of 6,339 flasks by perhaps a few hundred flasks, the total output being small compared with that of Europe. Only three mines in the United States produced in quantity in 1922—two in California and one in Texas. The output from Europe will probably show an increase, four new furnaces having been started at the Almaden mine, in Spain. Two or more furnaces were started at Monte Amiata, in Italy; Idria, in Carniola, will also show an increased production.

Several changes were made during 1922 that will influence the marketing of quicksilver, the most important to the American miner being the passage of the McCumber-Fordney Tariff Bill in October, which imposed a tariff of 25c. per pound, or $18.75 per flask, with corresponding duties on mercurials. This supersedes the Underwood tariff measure (1913-1922), which carried a 10 per cent ad valorem rate.

The Spanish Government has terminated its contract with the English house of Rothschild, which has sold the product of the Almaden mines for many years. The marketing is now done by the Spanish Government. It is reported that Spanish and Italian interests tried to form an international sales company, but the effort failed. However, the Italian producers, the Monte Amiata company, the Seile interests, and the owners of the Idria mine—the Italian Government—came to an understanding in regard to marketing, and this has stabilized Italian prices. The tendency has been to strengthen the market in the United States, with the result that the price has advanced from under $50 per flask in January to $72.30 per flask in December, in spite of the fact that importations during the period constituted a record. For the first ten months of 1922 imports totaled 18,225 flasks, of which 12,217 came from Italy, 4,467 from London, 700 from Spain, and 841 from elsewhere, mostly from Mexico. Undoubtedly much of this was exported in anticipation of a tariff, with the result that a considerable stock remains on hand; but domestic consumption is active, and, in view of the small amount being produced locally, accumulated stocks should not affect the market. In fact, the outlook for 1923 for the American quicksilver miner looks better than it has at any time since 1918. There should be a resumption of operations in many mines, and a considerable increase in production.

Price of Quicksilver, 1919-1922

Per Flask of 75 Lb.

	New York			
Month	1919	1920	1921	1922
January	$105.50	$90.192	$48.440	$49.960
February	89.84	84.432	49.545	48.295
March	71.56	92.611	46.796	50.204
April	72.94	102.192	45.423	52.280
May	83.12	89.560	47.000	54.885
June	93.25	90.154	46.846	55.115
July	104.68	90.333	44.950	55.000
August	107.08	83.806	45.028	57.593
September	102.52	75.000	42.660	67.640
October	86.35	67.200	39.840	72.560
November	90.74	58.417	39.804	71.521
December	98.27	49.577	49.212	72.300
Average for year	$92.15	$81.123	$45.462	$58.946

MINING IN 1922

Nitrate

By Huntington Adams
Consulting Engineer, 14 Wall St., New York

THE IMPORTANCE of the Chilean nitrate industry is not appreciated in the United States. The value of the exports of nitrate in normal times amounts to 60 per cent of the value of all the mineral exports of South America; among metal and mineral imports into the United States it is exceeded in value only by tin.

The productive capacity of the Chilean nitrate industry is about the same as it was before the war. Only three new plants have been erected since 1913, one of which was nearly completed when the war broke out. The existing plants (about 100) that can operate profitably under normal conditions have a productive capacity of about 2,500,000 metric tons of caliche (nitrate ore) per annum, and a productive capacity of about 2,500,000 metric tons of nitrate.

The industry continued to be affected throughout 1922 by the depression from which it has been suffering since 1920. Production and exports continued at about 40 per cent of capacity; but, during the first six months of the year, the immense stocks that had accumulated in Europe were reduced considerably, and the consumption for the year was about 75 per cent of capacity.

Cause of Depression in Nitrate Industry

The post-war depression in nitrate may be attributed to: (1) Lack of a free competitive market, in consequence of the centralization of sales in the hands of the Producers' Association, an organization that raised the price to abnormal figures in 1920 and 1921, discouraging the use of nitrate and giving an impetus to the demand for substitutes. (2) World-wide business depression since 1920, which has made it difficult to finance purchases of nitrate in Europe, and has reacted upon nitrate-consuming industries elsewhere, among the cotton growers of the United States, for instance. (3) Government action in Germany to hinder imports of Chilean nitrate, in order to favor the German manufacturer of synthetic products.

The abnormally high prices causes by the monopolistic action of the Producers' Association were reduced, at the end of 1921, by an agreement between the producers and the purchasing pool in London, hastened by a threat of intervention on the part of the Chilean Government. Statistics are given on page 154.

The consumption of nitrate in Europe, exclusive of Germany, was about the same in 1922 as it was before the war, with a tendency to increase. The purpose of restricting the imports of Chilean nitrate into Germany was to favor the German synthetic-nitrate plants. These, however, have been unable to supply enough for the agricultural needs of the country; and in consequence Germany is not self-supporting in regard to foodstuffs, as she used to be; in fact, the country is faced with starvation. The synthetic plants have not made profits commensurate with the capital involved (in terms of gold), even with the extremely low wages paid; and further extension of the synthetic industry seems unlikely if Germany has no belligerent intentions. The German Ministry of Agriculture has advocated the restoration of normal conditions by the importation of 500,000 tons of Chilean nitrate, and arrangements have been made for the purchase of 200,000 tons.

Silica

By H. E. Skougor and Andrew Walz
Consulting Engineers, 287 Broadway, New York

THE INCREASING DEMAND for silica products of standardized fineness, whiteness, and bulk has not yet resulted in the discarding of the crude production and finishing practices that have characterized the industry since its inception about fifty years ago. However, the continued pressure from the consumers of silica for a uniform product must sooner or later compel the industry to adopt the highly developed and advanced methods of ore dressing now in use in nonferrous mills. The industry has been dependent on the production of quartz as a byproduct in the mining of feldspar, although large amounts of silica have been produced by crude and inefficient methods of mining and grinding of quartz. This has resulted in a product of varying chemical and physical characteristics.

The availability of high-class and standardized products of silica for the arts would increase consumption and extend the application of the material. Ground silica has recently been utilized in the manufacture of phonograph records, artificial vulcanized rubber, and radio equipment. A considerable quantity is used as an adulterant and a diluent in the chemical and other manufacturing industries, in which its application is a trade secret. Its uses in soaps, cleansers, paint fillers, polishers, abrasives, glass, ceramics, concrete facing, weather- and heat-resisting paints, silica brick, refractories, insulators, filtration, foundry-mold washes, and dental materials are well known.

It is used extensively as a wood filler, for the manufacture of high-grade glassware, including transparent heat-resisting cooking utensils, and for sand-blasting work.

A standardized product with established sources of supply, produced under conditions that recognize present-day standards of mining and milling, is an urgent need of the silica industry, which is in a position similar to that of the petroleum industry previous to the utilization of geologic skill and efficient methods of refining, when manufacturers and ship owners hesitated before installing crude oil-burning equipment without being sure of regular supplies and a sufficient quantity of fuel of standard grade.

Fluorspar

Editorial Summary

THE FLUORSPAR INDUSTRY in 1922 could not boast of marked prosperity, although it was evident that a recovery from post-war depression had set in. Prices during the period under review were not satisfactory from the operator's point of view, and it is doubtful whether, on the whole, business was conducted at any appreciable profit. The output was limited to the demands of the steel companies, whose operations indicated a turnover amounting to only about 55 per cent of capacity.

In consequence of the limited reserves of ore in the known fluorspar mines, many steel companies are endeavoring to secure additional properties in anticipation of future requirements. One of the largest corporations has recently been drilling on two new properties and has secured an option on a third.

MINING IN 1922

Platinum

By J. M. Hill
Geologist, U. S. Geological Survey, San Francisco

IMPORTS OF PLATINUM in ingot and crude form during the first six months of 1922 totaled about 41,000 oz. Colombia supplied 16,000 oz.; England, 15,000 oz.; and France, 4,000 oz. During the same period, 6,700 oz. of osmiridium was imported, a large part from England, but some coming direct from Australia and some from France. It is said that the demand in the jewelry and electrical industries for metals of the platinum group was stronger than in 1921, but that supplies were adequate. The quoted price for platinum during 1922 was about $87.50 per ounce, with a slight raise during February and again toward the end of the summer, when jewelers came into the market, bringing the price to $108 per ounce. The price rose again toward the end of the year, when the demand for jewelry was good.

Price of Platinum, 1918-1922

Dollars per Troy Ounce in New York Market

Months	1918	1919	1920	1921	1922
January	105.92	104.85	154.23	73.400	97.260
February	107.68	100.43	151.59	70.227	89.545
March	108 (nom.)	99.20	138.56	72.463	87.500
April	108 (nom.)	99.85	127.04	73.404	87.500
May	106.27	102.60	97.50	73.740	85.529
June	105.00 (a)	105.80	85.19	74.942	87.212
July	105.00 (a)	105.90	83.94	70.440	90.180
August	105.00 (a)	107.60	111.44	73.222	98.370
September	105.00 (a)	128.70	115.20	75.960	117.280
October	105.00 (a)	132.21	101.70	81.800	109.440
November	105.00 (a)	136.74	84.75	82.609	108.000
December	105.54	151.35	79.62	78.192	113.600
Year	105.95	114.61	110.90	75.033	97.618

(a) Fixed price.

The Port Colburn refinery of the International Nickel Co. was again put in operation in the fall of 1922; it will add slightly to the supplies of platinum and palladium, and a small increase in the output of these metals may be expected from the copper refineries. In Colombia, an accident to No. 1 dredge of the South American Gold & Platinum Co. caused a shutdown. The No. 3 dredge is not yet in operation, in consequence of difficulties in getting the boat to its dredging grounds, on account of extremely low water. The dryness of the season in Colombia should result in increased production of crude platinum by native labor, although the output from this source is always difficult to estimate.

The Soviet government in Russia still refuses to sanction the reopening of mines held by foreign capital, although it is reported that a comparatively large amount of platinum has been recovered by small operators, and this has evidently reached the markets through England and France. Two English-controlled companies, the Anglo-Ural Platinum Trust and the Anglo-French-Ural Syndicate, have been formed to undertake the development of the Ural platinum fields as soon as conditions permit.

In the United States little change has occurred in the mining of crude platinum, although there was a revival of interest in the Beegum-Peanut-Hayfork field, in California. The Salt Chuck mine, in Alaska, and the Boss mine, in Nevada, were not operated in 1922, and little work seems to have been done at the Rambler mine, in Wyoming.

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Chromite

By Edward Sampson
Geologist, U. S. Geological Survey, Washington, D. C.

THE CHROMITE INDUSTRY throughout the world has now reached a fairly stable condition. New Caledonia and Rhodesia, which in 1913 furnished about three-quarters of the world's supply, are now able to maintain an output in the same proportion, even if they are not actually doing so. In 1922, Baluchistan more than filled the place occupied by Russia and Turkey in 1913, when together they produced about 18 per cent of the total. The deposits in Baluchistan, in consequence of the railroad construction in 1917, are now yielding a large output. The shipments probably exceeded 30,000 tons, and in addition about 6,000 tons was said to be ready for shipment at Karachi at the end of 1922. Much of the Baluchistan ore, which contains from 50 to 53 per cent Cr_2O_3 and is low in silica, is said to be marketed in Germany.

Exploitation of Foreign Deposits

The chromite deposits in the State of Mysore, India, from which nearly 34,000 tons was marketed in 1918, are not being exploited at present and are said to have reverted to native control. The depression in Rhodesia, due to overproduction, lasted throughout the first half of 1922. Large stocks were stored at Beira and London in the early part of the year, and the mines were closed. Up to the end of June, less than 10,000 tons was shipped; but in July and August, the last months for which production figures are available, the quantity reached about 26,000 tons. A considerable amount of low-grade ore was mined in Greece and shipped to the United States for refractory purposes. The present turbulent conditions in the Smyrna district of Turkey, where lie the only recently exploited deposits, have made mining under foreign supervision impossible. Even the purchase of supplies from native sources is subject to such uncertainty and extortion that the Macri field has been abandoned. A single cargo of Turkish chromite was shipped early in 1922.

Domestic Chrome Mining Inactive

It appears that only two chrome mines in the United States were in operation in 1922. The Sullivan Mining Co., of California, is shipping 55 per cent ore, and reports brighter prospects for 1923. F. W. Peet shipped four cars of 45 per cent ore from Baker City, Ore. However, a transportation charge of $12 from his mine, near Prairie City, to Baker City left him only $4 a ton to cover mining costs. This case is typical of the difficulties against which all domestic consumers have to contend.

Up to Sept. 21, when the new tariff went into effect, the total imports into the United States were about 62,000 tons. This rate would make a total of about 86,000 tons for 1922, as compared with 82,000 for 1921. Of the amount up to Sept. 21, Rhodesia is probably to be credited with 54 per cent, New Caledonia 19 per cent, Greece and India 11 per cent each, and Turkey 5 per cent, accounting for 99 per cent. The average price of chromite in 1922 (50 per cent Cr_2O_3) was about $22.50 per ton.

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MINING IN 1922

Tungsten

By Frank L. Hess
Geologist, U. S. Geological Survey, Washington, D. C.

THE NOTABLE FEATURES of the tungsten industry in 1922 were (1) the big output from China at low prices, probably averaging less than $3 per unit, f.o.b. New York or London; (2) the passage of a tariff act, placing a duty of 45c. per pound on the tungsten in ore, and heavy duties on tungsten in any manufactured form imported into the United States; (3) the accumulation of large stocks of ore, metal, and ferrotungsten in this country; (4) the large quantity of ore used by Germany; and (5) a second year without production in the United States.

Available reports indicate that, in all Caucasian countries, mining conditions were much the same as in the United states. But it is estimated that shipments from China in 1922 amounted to perhaps 3,800 long tons of ore containing 68 per cent WO_3, equal to the world's production in 1921. Production in 1922 will probably reach 6,000 short tons of concentrate, containing 60 per cent WO_3.

The United States imported, up to Sept. 21, 1922, when the tariff law went into effect, 1,854 short tons of tungsten ore, valued at $279,190, which probably averaged 67.5 per cent WO_3, and 1,037,069 lb. of tungsten and ferrotungsten, valued at $380,732, equivalent to about 1,166 short tons of 60 per cent concentrate. The total imports to Sept. 21 were therefore equivalent to about 3,252 tons of 60 per cent concentrates, or about a year's normal consumption before the Great War.

Effect of the Tariff Shows Need for Governmental Stimulus

The year opened with Chinese ore, carrying 67½ per cent WO_3, at $2 per unit in New York, and Bolivian ore of higher grade at $2.50 to $3 per unit; in March, even with the assurance of the tariff, the price of Chinese ore dropped to $1.80 per unit for material that was a little "off color," but usable. Soon after the tariff act became a law, placing a tax of $7.14 on the importation of a short-ton unit of WO_3 in ore, heavy buying commenced, showing that many steel makers had not covered their needs.

One firm in Great Britain is known to keep on stock 3,000 long tons of 65 per cent ore. German firms, with their usual foresight, have been buying heavily of the good and cheap Chinese ore, and turning it into a more concentrated product. Nobody knows how long the supply will last. The lamentable part of the situation is that, with all this low-price ore piled up in this country, with ore still to be bought cheaply, with the recollection of the desperate needs of the country four years ago, the government cannot be induced to store at least 10,000 tons, against the day when we may again experience the same need. It would be a cheap form of insurance, thus providing all the tungsten needed for at least six months of scarcity. The amount, if taken from the market, would buoy it up greatly, and give our mines a chance to resume work under normal market conditions.

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Nickel

By Thomas W. Gibson
Deputy Minister of Mines, Toronto, Ont., Canada

NICKEL MINING is recovering from the state of semi-paralysis into which it lapsed as a result of the war. In the Sudbury district of Ontario, Canada, three mines are producing. The International Nickel Co. of Canada reopened the Creighton mine on Aug. 26, 1922. At first only 130 men were employed, but in November the number was increased to 230. The smelter at Copper Cliff resumed operations on Sept. 1, since when two, and for a short time three, furnaces have been in blast.

The Murray mine and the Nickelton smelter of the British America Nickel Corporation were idle in 1922. Part of the refinery at Deschenes, Que., was put in operation during the summer. The Mond Nickel company, since June last, has shipped to Wales a large amount of matte, its storage rooms now being empty for the first time since the armistice.

The nickel obtained in matte production in 1922 was about 8,500 tons, an increase of 1,000 tons over 1921 production. The accumulated stock of refined nickel has been reduced to almost nil, but a considerable amount of matte remains to be treated.

In New Caledonia, the other commercial source of nickel, the business has been lifeless. In January, 1922, Le Nickel sales dropped 50 per cent and continued to decrease thereafter. The smelter has operated continuously, but under unfavorable conditions, owing to the high cost of fuel and the low rate of exchange in Australia. The nickel furnaces in England have remained idle. The refinery at Havre has been working steadily, though at times with a reduced output. The mill at Iserlohn, Germany, after being remodeled, has resumped operations.

Talc

By Raymond B. Ladoo
Mineral Technologist, U. S. Bureau of Mines, Washington, D. C.

THE EFFECTS of the depression of 1921 in the talc industry were apparent during the first three months of 1922. There was a gradual increase in demand in April, which became more marked in August and increased to a maximum in October, after which there was a slight decline. During the latter part of the year the demand for California talc was nearly as great as it was in 1920. Estimates by producers indicate that the total production in the United States for 1922 will be between 65 and 85 per cent of the production of 1920; it will show a considerable increase over the production of 1921.

Prices, particularly of Vermont talc, were low at the beginning of 1922, and declined during the first half of the year, but became steady during the second half. The prices on California talc remained steady at about the 1921 average. Roofing-grade talc slumped to $5 per ton in November.

The Canadian talc production for the first six months of 1922 was 4,890 tons, valued at $67,180. Exports for this period aggregated 4,969 tons, valued at $73,857, nearly twice as much as for the same period in 1921.

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Sulphur and Pyrites

By Raymond Foss Bacon
Consulting Chemist, Chemists' Club, 52 East 41st St., New York

THE USE OF SULPHUR in place of pyrites for the manufacture of sulphuric acid, which assumed large proportions in the United States during the war, continued through 1922. It is becoming increasingly evident that sulphur has many advantages over pyrites as a raw material in this field; in 1922, only about 225,000 tons of pyrites was imported into this country, almost all of which came from Spain, the amount from Canada being negligible. America still dominates the world's sulphur markets, about 80 per cent of the total supply being produced by three companies—the Texas Gulf Sulphur Co., the Union Sulphur Co., and the Freeport Sulphur Co. The world's consumption in 1922 was about 1,500,000 tons, of which the United States and Canada absorbed about 1,000,000. The American sulphur industries operated at about 60 per cent of capacity; but the year was a prosperous one, nevertheless, as maximum output of the three companies mentioned is probably considerably greater than the present normal world consumption.

Of the principal consuming industries, the paper and pulp trade operated in 1922 at about 70 per cent of capacity, the chemical industry at about 80 per cent, the fertilizer industry at 45 to 50 per cent, and the explosives industry at 40 per cent. The business outlook for all of these is promising.

The outlook for pyrites is not so favorable. Apparently it cannot be sold to compete with sulphur in this country unless the controlling interests choose to sell at a price that would invite disastrous competition in their own markets.

Bauxite and Aluminum

By J. M. Hill
Geologist, U. S. Geological Survey, San Francisco

THE DOMESTIC bauxite-mining industry revived considerably during 1922 from the severe slump of the previous year. It is estimated that the production will prove to be more than twice that of 1921, when the total output was 139,550 long tons. The demand for bauxite increased, being particularly strong in the abrasive industry. On Jan. 1, 1922, domestic bauxite was quoted, f.o.b. shipping points, as follows: Dried, $8 to $10 per long ton; pulverized and dried, $12 to $15 per long ton; calcined, $20 per long ton. These prices changed in March, but remained constant thereafter throughout the remainder of the year, at $6 to $9 for dried, $12 to $14 for pulverized and dried, and $22 to $25 per ton for calcined. Foreign bauxite during most of the year was quoted at $5 to $8 per ton, c.i.f. eastern United States ports.

Imports Show Large Increase

In the first six months of 1922, approximately 22,000 tons of bauxite was imported, or nearly as much as during the whole of 1921. A large part of this was from Dalmatia and South America, some from France, and, it was rumored, a small quantity from India. Under the Tariff Act of 1922 a duty of $1 per long ton is imposed on all imported bauxite, and 1c. per pound ($20 per short ton) on imports of bauxite concentrates (aluminum hydrate).

The price of domestic bauxite, crushed and dried, f.o.b. shipping points, at the end of 1922, was $6 to $9 per ton.

A large bauxite field has been discovered in south-central Mississippi, where deposits of promise in Tippah and Pontotoc counties have been prospected by the Mississippi Bauxite Co. The domestic aluminum plants, as far as can be judged, did not operate at full capacity in 1922, although the production was doubtless considerably larger than in 1921.

Passage of Tariff Act Raises Price

Quotations on domestic aluminum were constant throughout the first half of the year at 20c. per pound for 99 per cent; 19c. per pound for 98 to 99 per cent; and 18c. per pound for 94 to 98 per cent grade of metal. In August the prices were advanced ½c. per pound; and upon the passage of the tariff bill they were again advanced from 1 to 2c. per pound on all grades.

Imports of aluminum and aluminum alloys in crude form are dutiable at 5c. per pound; semi-manufactured aluminum is dutiable at 9c. per pound; aluminum foil at 35c. ad valorem; aluminum powder at 12c. per pound; and household ware, at 11c. per pound and 55 per cent ad valorem.

Graphite

By Benjamin L. Miller
Professor of Geology, Lehigh University, Bethlehem, Pa.

GRAPHITE PRODUCTION in 1922 was almost at a standstill, notwithstanding the general improvement, particularly in the iron and steel industry. Considerably more time will be required for the consumption of the surplus on hand at the end of the war. To so great an extent is graphite an international commodity that it is impossible to resume active mining operations until the supplies of all countries have been exhausted. Ceylon, Madagascar, Japan, Austria, Bavaria, Czechoslovakia, and the United States are competing in the same market; and most if not all of them are selling old stocks at far less than the cost of war-time production, and even less than the present cost. In March, 1922, 18,000 tons of unsold Madagascar graphite remained on the island, and a large quantity in France. Stocks in Ceylon are supposed to be extensive. Much unsold graphite is in the hands of the Alabama producers.

Four companies operated a part of 1922 in Alabama. In Texas, also, there was a small production. No work was done in Pennsylvania; in New York, the Dixon Crucible Co. closed its mines at Graphite. Canada produced no graphite during the year.

The chief item of interest to producers was the tariff legislation passed whereby an import tariff on crude or refined was levied as follows: Amorphous, 20 per cent ad valorem; crystalline lump, chip, or dust, 20 per cent ad valorem; crystalline flake, 1½c. per pound.

Prices at the end of 1922 were low, owing to large offerings.

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MINING IN 1922

Uncommon Ores and Metals

Cadmium—Cerium—Selenium—Tellurium—Titanium—Thallium—Zirconium

By H. C. Meyer
Vice-president, Foote Mineral Co., Philadelphia, Pa.

A NEW USE for cadmium was developed in 1922, by which it is employed in much the same manner as zinc, to prevent surface oxidation. Very little is imported. Toward the end of the year, considerable quantities were exported to England and Continental Europe. The price during the first half of 1922 ranged from $1 to $1.10 per pound. During the last half of the year there was a decided advance, in keeping with the advance of almost all metals, to $1.15 to $1.35 per pound. The sulphide sold during the first half from $1.25 to $1.35 per pound, and in the last half of the year it advanced to $1.25 to $1.40 per pound. No statistics are available as to the actual tonnage produced in 1922, but it is probably approximately 100,000 lb. of the metal and 50,000 lb. of sulphide.

Cerium

The demand for cerium metal and ferrocerium during 1922 was comparatively light. Only one American manufacturer is producing. As a protection there is an embargo on all foreign cerium and ferrocerium.

No important fluctuation in price occurred during the year, the alloy selling at $10 to $15 per pound in prepared sizes. Considerably lower figures were quoted for export shipments to meet the competition of German and French manufacturers. A new commercial use has been developed for the cerium residues in the production of certain types of optical glass.

Selenium

About nine-tenths of the selenium produced is consumed by the glass industry. A considerable amount was exported in 1922, the United States being the chief producer. During the first half of 1922 the price ranged from $1.75 to $1.80 per pound. During the latter half there was a slight advance, and the price ranged from $1.90 to $2 per pound. No statistics are available, but in a report by the U. S. Geological Survey the production for 1921 was given as 59,807 lb. It is expected that the production of 1922 will greatly exceed this figure.

Selenium is an element, resembling sulphur and tellurium chemically, and is obtained as a byproduct in the electrolytic refining of copper, the element being extracted from the so-called anode mud. Other important sources, which will be developed on a commercial scale in the near future, are known to exist in Mexico and Siberia. The exploitation of these will affect the market in the United States. It has been shown that the element can be produced at comparatively small cost.

It appears on the market as a grayish-black powder, over 99 per cent pure. As a decolorizer in the glass industry it is used in the form of sodium or barium selenite, mixed with nickel and cobalt compounds and diluted with some inert filler, generally feldspar. The element has been used in the electrical industry for the manufacture of the so-called selenium cells, the resistance of which varies under the influence of light. A special type of cell has been developed recently for the transmission of pictures by wireless.

Titanium

There were no important developments in titanium during 1922. The discovery of large deposits of ilmenite in Canada and in Florida, where it is separated from beach sand by concentration, greatly reduced the consumption of rutile, the native oxide of titanium. Formerly, large quantities were used in the production of ferrotitanium, but ilmenite has been found as satisfactory and is considerably cheaper. The dioxide, however, is still used in the ceramic industry as a coloring agent and also in the electrical industry in the manufacture of hollow carbon electrodes for use in the flaming arc.

Only two important commercial deposits are being worked at the present time: in Risor, Norway, and in Virginia. Commercial deposits are known to exist in Australia, but owing to a lack of any important commercial demand these have not been developed. The Norwegian product occurs in the form of fine black concentrate carrying from 93 to 98 per cent titanium dioxide. The Virginia mineral occurs in the form of reddish-brown concentrate.

The price of high-grade rutile during the first half of 1922 ranged from $200 to $225 per ton. Owing to increased labor costs at the mines, the Norwegian product advanced to $250 per ton during the latter half of the year. The price of the American mineral is about the same as that of the imported. Probably not more than 75 to 100 tons are consumed in the United States annually. The price of ilmenite during the year ranged from $8 to $25 per ton. This is for material carrying a minimum of 45 per cent TiO_2.

Tellurium

The consumption of tellurium in the United States is less than one ton per year. It has been estimated that the output could be increased with present facilities to about fifty to sixty tons per year. A development in connection with its commercial use in 1922 was the discovery that the addition of diethyl telluride to gasoline gave increased mileage and power. Should it be employed in large quantity for this purpose, it is estimated that about 1,500 tons would be required annually to treat all of the motor fuel consumed. The price remained almost stationary throughout the year, ranging from $2 to $2.50 per pound.

Thallium

A few years ago thallium was considered a very rare

metal, but more recently it has been produced in commercial quantities. A recent use is in the production of a sensitive electrical device similar to the selenium cell, the resistance of which varies markedly under the influence of light.

During the first half of the year the metal sold from $16 to $18 per pound. During the latter half, new commercial sources were developed, and the price dropped to about $8 per pound. The consumption is probably about 25 to 50 lb. per year.

Zirconium

The discovery of rich zirconium ore in Brazil had a stimulating effect on the industry in 1922. It carries from 82 to 85 per cent zirconium dioxide, and is a true oxide, and not a mixture of zircon and brazilite. By refining methods, it is possible to bring the oxide content up to 90 to 95 per cent.

A comparatively large tonnage of the hydrated oxide was produced during the early part of 1922, and used by the enameling industry as a substitute for tin oxide and antimony oxide. It is claimed to impart certain desirable properties to the enamel over and above its value as an opacifying agent. A small quantity of the pure white oxide was also produced, but owing to technical difficulties the price was comparatively high.

Satisfactory progress is being made in the development of a commercial process for the production of zirconium metal. It is only a question of time when this element will be as common and as cheap as tungsten metal powder. What little is known of its physical properties indicates that it will be an important factor in the ferro-alloy industry.

The price of zirkite remained unchanged during 1922, the cement selling at 2¾c. per pound in carload lots. Dead-burned zirkite, in grain or powder form, sold at 3½c. to 5c. per pound. Zirkite bricks in standard shapes sold at 45c. to 65c. each in carload lots. The 99 per cent oxide sold during the year at 75c. to $1.25, and the hydrated oxide at 40c. to 60c. per pound.

Mica

Editorial Summary

THE PHENOMENAL growth of the radio-equipment industry, to satisfy the demands of hundreds of thousands of amateurs, and the revival of building activity in 1922, were the principal factors to account for the increase in the consumption of mica during the year. An important requirement for sheet mica is in the electric industry, where its ability to withstand heat, and its high electrical resistance, make it invaluable. Nearly two-thirds of the ground mica used is required for the manufacture of roofing.

India continued to supply the greater part of the high-grade sheet mica used, although North Carolina, New Hampshire, and Virginia were substantial producers in 1922. The output from Carolina, of a low-grade ground product suitable for roofing purposes, increased considerably during the year. Efforts are being made to stimulate the industry in New Mexico.

The increased tariff of 30 per cent for most grades of sheet, and 20 and 25 per cent for low- and better-grade ground mica, will probably be reflected in an increased output in 1923.

Manganese

By H. A. C. Jenison

Geologist, U. S. Geological Survey, Washington, D. C.

LITTLE CHANGE has occurred in the manganese industry in recent years, but during and since the struggle for a tariff, many interesting features developed. The tariff won, in part at least, by an attack on the estimates of manganese ore reserves made by the U. S. Geological Survey. The estimates by the American Mining Congress are so much greater that there is no hope of reconciliation. The War and Navy departments have been unable to make a choice. The Institute is now making an independent estimate.

It is too early to determine what effect the tariff will have upon the industry, but as the weighted average cost of production and delivery of domestic ore is more than $20 per long ton, it appears that foreign competition is not eliminated. The domestic mines cannot produce more than a small proportion of the domestic requirements, and it is doubtful whether more than a few favorably placed domestic mines can operate at a profit. The tariff will probably add from $5,000,000 to $10,000,000 per year to the cost of steel.

Producers of low-grade ore hope that the tariff will encourage the use of manganese and permit the operation of their properties. It is likely that the concentration of low-grade ores can be made as profitable as are the operations in many high-grade mines.

The shipments of manganese ore containing 35 per cent of manganese or more from domestic mines in 1922 (from reports of producers for the first eleven months and an estimate for December) totaled about 13,500 gross tons, valued at $457,000, compared with 13,531 gross tons, valued at $495,097, in 1921. The shipments of ore containing 10 to 35 per cent manganese totaled about 352,000 gross tons, valued at about $1,232,000, compared with 8,439 gross tons in 1921, valued at $42,755. About 251,000 gross tons of ore, containing 5 to 10 per cent of manganese, was shipped, valued at about $630,000, compared with 62,670 gross tons in 1921, valued at $147,576. Up till Sept. 21, 266,969 gross tons of manganese ore was imported into the United States.

Arsenic

Editorial Summary

THE FEATURE of the arsenic industry in 1922 was the significant rise in price, from about 7c. per pound in April to about 13½c. in December. This appreciation was due to the ravages of the boll weevil in the cotton districts and the consequent need for increased supplies of arsenical insecticide. The subject was reviewed recently in the *Journal-Press*.

One of the most important plants erected during the year will treat scorodite ore (cupreous arsenate of iron) at Salt Lake City. It has been constructed by the Salt Lake Insecticide Co. at a cost of about $150,000. A wet process is used, the ground ore being treated with caustic soda, and the arsenic precipitated with lime, as calcium arsenate. The initial capacity of the plant is about twenty-five tons per day.

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MINING IN 1922

Chronology

JANUARY

Jan. 1—Anaconda company reports first order for copper shingles.
Jan. 1—Wages reduced 50c. per day by Hollinger, Dome, and McIntyre companies at Porcupine, Canada.
Jan. 5—Freight rates on lead bullion and other smelter products reduced from Tacoma, Kellogg, Northport and Montana smelting points.
Jan. 9—Miners in coal and gold mines in Transvaal strike in protest against increased employment of black labor.
Jan. 11—New York section of A.I.M.E. officially opposes licensing of engineers.
Jan. 15—Seventeen men killed in a slide of tailing on the dump of the San Francisco del Oro mine, near Parral, Mexico.
Jan. 19—Presentation at Eureka, Utah, of silver medals, gift of *Engineering and Mining Journal*, to the winning shaft-sinking crew of the Walter Fitch Co.

FEBRUARY

Feb. 1—Three blast furnaces and two reverberatories start at the Calumet & Arizona plant at Douglas, Ariz.
Feb. 4—Stockholders of the Hecla Mining Co. ratify deal made with the Star Mining Co.
Feb. 7—Canadian Government reduces tax on asbestos mined for export.
Feb. 11—Eugene R. Day, prominent in mining in the Northwest, dies.
Feb. 13—Work reported resumed at Village Deep, Roodeport Deep, East Rand, and Crown mines, on the Witwatersrand.
Feb. 14—Mining & Metallurgical Society of America discusses proposed new mining law and objects to provision making boundaries of claims cardinal lines.
Feb. 14—Northwest Mining Convention, convened at Spokane, Wash., opposes revision of mining law.
Feb. 15—Strike at Mount Morgan, Queensland, settled.
Feb. 15—Wages raised in Tintic district, Utah, and strike settled.
Feb. 15—Inspiration Consolidated has four units of mill in operation.
Feb. 15—Suit of Hollinger Consolidated Gold Mines *vs.* Northern Canada Power Co., for damages arising from an alleged failure to supply power, is dismissed.

MARCH

March 1—Canadian Institute of Mining and Metallurgy opens meeting at Ottawa.
March 4—Violence accompanies miners' strike at Johannesburg.
March 18—Strike at Johannesburg, which had assumed the proportions of a revolution, called off by the South African Industrial Federation of Labor.
March 19—Philip B. Argall, mining and metallurgical engineer of international reputation, dies at Denver, Colo.
March 20—Silver purchases under Pittman Act pass 100,000,000 oz. mark.
March 27—Utah Apex Mining Co. resumes operations.
March 27—United Comstock Co. completes 10,000-ft. tunnel in the Gold Hill district of Virginia City, Nev.

APRIL

April 1—Calumet & Hecla and its subsidiaries, Ahmeek and Isle Royale, in northern Michigan, resume operations. Porphyry copper companies resume on a limited scale.
April 2—John Ballot, president of Minerals Separation North American Corporation, dies in New York.
April 4—Knox Taylor, president of the Taylor-Wharton Iron & Steel Co., dies at North Bridge, N. J.
April 10—Fordney Tariff Bill reported to Senate.
April 10—Property of the Arizona Hercules Copper Co. sold at sheriff's sale for $3,600,000.
April 11—Fire destroys mill of Elko Prince Mining Co., at Midas, Nev.
April 14—Walk-out of miners occurs in Joplin-Miami district almost simultaneously with decision of operators to raise wages, the men going back to work almost immediately.
April 15—Jacob D. Wolf reported to have brought suit against Minerals Separation company for alleged infringement of flotation patent.
April 17—Old Dominion company starts blast furnace at Globe, Ariz., as a preliminary to a general resumption of mining operations.
April 22—Committee of A.I.M.E. finishes conferences with War Department on the subject of war minerals.
April 22—D. R. Crissinger, Comptroller of the Currency, urges the maintenance of the gold basis.
April 25—Fire breaks out at the Consolidated Virginia mine, in Virginia City, Nev. Area is sealed with concrete bulkheads, and no loss of life occurs.
April 27—Hearings on mining law revision started at Washington.
April 28—Minerals Separation company and the Jackling interests agree on settlement of flotation disputes.

MAY

May 1—American Gold and Silver Institute formed, with H. N. Lawrie as managing director.
May 6—Important discovery of iron ore is reported from the Cuyuna Range district of Minnesota.
May 6—American Smelting & Refining Co. joins forces with the Metals Exploration Co. in a program to ease the smelting situation in Colorado.
May 9—American Zinc Institute meets at St. Louis. E. H. Wolff is re-elected president.
May 11—Lackawanna Steel Co. merges with Bethlehem Steel Co.
May 13—Reported that Sulphide Corporation of New South Wales has suspended operations at Cockle Creek.
May 13—H. M. Howe, a leading metallurgist and sometime professor of metallurgy at Columbia University, dies at Bedford Hills, N. J.
May 24—Power house and other buildings of Democratica Mining Co. destroyed by fire at Cananea, Mexico.
May 24—General horizontal reduction of 10 per cent in freight rates announced by Interstate Commerce Commission.
May 26—Large portion of the mining town of Manhattan, Nev., burned.
May 27—Evans Committee, organized in March, 1921, to investigate the management and affairs of the American Smelting & Refining Co., submits a majority and a minority report.
May 27—Removal in sections of piece of mass copper weighing fourteen tons at Ahmeek mine, Michigan, completed.
May 27—Anode plant of the Nichols Copper Co., Laurel Hill, N. Y., destroyed by fire.

JUNE

June 1—Moctuzuma Copper Co. starts first section of 3,000-ton mill and concentrating plant at Nacozari, Sonora, Mexico.
June 8—Hearings on mine law revision at Washington brought out fact that the Secretary of the Interior's opinion was that "it would be inadvisable at this time to pass a law radically changing the general laws now in effect."
June 10—Merger effected of the Republic, Midvale, and Inland Steel companies.
June 10—Reports received that suit for $500,000 had been brought by Kennedy Mining & Milling Co. against the Argonaut Mining Co., both of Jackson, Calif., for damages resulting from fire in the latter company's mine three years ago. The Argonaut company files counter suit for $800,000.
June 20—Western Mining Conference opened at Denver, Colo.
June 24—Labor shortage reported in Michigan copper district.
June 24—Proposal announced to establish a silver export association to insure the more orderly marketing of silver produced in the United States.

JULY

July 1—The Hollinger company purchases the Schumacher property adjoining, at Timmins, Ont., Canada.
July 1—Increased shortage of miners reported from the Michigan copper district.
July 3—International Mining Convention opened at Nelson, B. C.
July 5—New Cornelia Copper Co. resumes operations at Ajo on full scale.
July 8—Merger of the Columbia Steel Co. with interests controlling coal mines and iron-ore deposits in Utah.
July 9—Fire destroys concentrator of the Nevada Consolidated Co. at McGill, Nev.
July 15—Fire at Tomboy Gold Mining Co.'s plant at Telluride, Colo., causes much damage.
July 15—Reported that the Tamarack & Custer mine and the Hercules mine, in the Coeur d'Alene district of Idaho, have resumed operations.
July 20—Arthur S. Dwight and Arthur F. Rand are decorated with the Croix de Chevalier de la Legion d'Honneur by the French Government for distinguished service during the war.
July 27—Ticket nominated by the management of the American Smelting & Refining Co. elected at the annual meeting of company held in Jersey City.
July 29—Operations reported resumed at the zinc oxide plant of the Empire Zinc Co., at Canyon City, Colo.

MINING IN 1922

AUGUST

Aug. 1—The Greene-Cananea Copper Co. resumes operations.
Aug. 5—H. N. Lawrie, managing director of the American Gold & Silver Institute, anticipates fifteen more months of "dollar" silver.
Aug. 5—Rich strike reported in the Florence silver mine, Ainsworth district, British Columbia.
Aug. 6—James R. Thompson, prominent in the Lake Superior iron-ore district, dies at Ishpeming, Mich.
Aug. 14—Operations resumed at the plant of the British American Nickel Corporation at Deschenes, Que., Canada.
Aug. 15—Establishment reported of "farthest north" mining college at Fairbanks, Alaska.
Aug. 15—Cananea company resumes production of copper.
Aug. 22—Gardner F. Williams, well-known diamond-mine engineer, dies at San Francisco.
Aug. 25—Utah Metal Mining Institute meets at Park City, Utah.
Aug. 26—Fordney-McCumber Bill passes Senate; tariffs in metal schedules are lower than those fixed by House.
Aug. 28—Lake Superior Mining Institute opens meeting at Houghton, Mich.
Aug. 27—Fire traps 47 men in the Argonaut mine, Jackson, Calif.
Aug. 28—National Safety Council opens congress at Detroit, Mich.

SEPTEMBER

Sept. 1—Reports indicate that International Nickel Co. has resumed operations at Copper Cliff, Ont., after a shutdown of eighteen months.
Sept. 1—Denver mint resumes purchase of silver, as designated point of delivery under the Pittman Act.
Sept. 2—Nipissing Mining Co. enters Kirkland Lake district of Ontario.
Sept. 2—U. S. Employment Service reports shortage of labor in some localities and general termination of unemployment.
Sept. 2—Reports indicate that fire has destroyed valuable equipment of Cornucopia Mines Co. in eastern Oregon.
Sept. 2—Arthur W. Ambrose appointed assistant director of the U. S. Bureau of Mines.
Sept. 4—Fire destroys the mill of the O'Brien company at Cobalt, Ont., Canada.
Sept. 8—American Engineering Council adopts resolution authorizing the appointment of a commission to study the Muscle Shoals problem.
Sept. 9—Reports from Washington indicate that the opposition to the proposed new mining law will cause the abandonment of further action by the House Committee on Mines and Mining.
Sept. 15—Increases in wage scale reported from Utah, Arizona, and other western points; also from the Lake Superior copper district.
Sept. 16—Clearing house for prospectors established at Spokane, Wash.
Sept. 16—Combination of leading tungsten-mining companies reported from Tasmania.
Sept. 16—Statistics show that mine products are forming an increasing proportion of the freight passing through the Panama Canal.
Sept. 18—Bodies of the 47 miners entombed in the Argonaut mine at Jackson, Calif., are recovered, it being evident that all had died a few hours after the outbreak of the fire.
Sept. 19—Mill and plant of the Clio mine, near Jacksonville, Calif., destroyed by fire.
Sept. 20—Australian arbitration court authorizes a reduction in the wages of miners.
Sept. 25—A.I.M.E. meeting opens at San Francisco.
Sept. 25—First unit of the new mill and cyanide plant of the United Comstock Mining Co. reported in operation.
Sept. 26—Coroner's jury investigating Argonaut mine disaster recommends underground connections between contiguous mines.
Sept. 30—Supreme Court of Arizona sustains decision in favor of United Eastern Mining Co., in suit brought by Tom Reed Gold Mining Co.

OCTOBER

Oct. 1—Granby Consolidated Mining & Smelting Co. increases wages to all employees.
Oct. 2—New mill and cyanide plant of the Candelaria Mines Co. starts operating at Candelaria, Nev.
Oct. 4—Forest fires of serious dimensions reported from the mining districts of northern Ontario, Canada.
Oct. 7—American Mining Congress convenes at Cleveland, Ohio.
Oct. 10—Isaac Guggenheim, well known in the mining and smelting industries of the United States, dies at Southampton, England.
Oct. 14—New York section of the A.I.M.E. passes resolution expressing belief that the time has come for the United States to participate in solving the economic problems of Europe.
Oct. 14—Premier Gold Mining Co. announces fourth dividend for 1922, of $750,000.
Oct. 15—Miners in Tonopah and Divide districts of Nevada strike after refusing a 25c. increase in wages.
Oct. 16—Tonopah and Divide strike settled. Men are paid an increase of 50c. per shift, bringing wages to $5.75.
Oct. 16—First public hearing by committee appointed by Governor Stephens to investigate Argonaut mine disaster is held at San Francisco.
Oct. 18—John Hays Hammond made chairman of the U. S. Coal Commission at first meeting.
Oct. 21—Dr. S. W. Stratton, twenty-one years director of the Bureau of Standards, resigns to become president of the Massachusetts Institute of Technology.
Oct. 23—Flotation plant started at the Betty O'Neal mine, Battle Mountain, Nevada.
Oct. 28—Province of Quebec, Canada, reduces royalty payable to provincial government from $5 to $2.50 per ton of asbestos.
Oct. 28—Rich ore discovery reported from the Dome mine, in Ontario, Canada.

NOVEMBER

Nov. 4—Reported that suit of Iron Cap Copper Co. *vs.* Arizona Commercial Mining Co., involving apex problems, is settled in favor of the Iron Cap company.
Nov. 4—Proposal to subsidize gold producers is revived in Washington.
Nov. 4—Consolidated company, of Trail, B. C., raises wages.
Nov. 6—United Verde Copper Co. and United Verde Extension Mining Co. default in tax payments to test legality of Arizona mine law.
Nov. 8—New Modderfontein company, in Transvaal, South Africa, announces plans for the building of a new circular shaft to cost £200,000.
Nov. 11—Resignation reported of Dr. George Otis Smith, director of the U. S. Geological Survey, in order that he might qualify to serve on the President's Coal Commission.
Nov. 11—Oliver Iron Mining Co. announces raise to all salaried men.
Nov. 16—Gold metal of Institution of Mining and Metallurgy presented to Sir Alfred Keogh.
Nov. 18—Reports indicate the resumption of operations at the Magna mill of the Utah Copper Co.
Nov. 20—Northwest Mining Section of the National Safety Council meets at Butte.
Nov. 24—Total purchases of silver under the Pittman Act reach 142,602,412 oz.. leaving about 65,000,000 oz. to be purchased.
Nov. 25—Appointment announced of Prince Gelasio Caetani, well known in the West as a metallurgist and an ore-dressing engineer, and sometime special contributor to the *Mining & Scientific Press*, as Italian Ambassador to the United States.
Nov. 25—Price of radium drops from $120,000 to $70,000 per gram.
Nov. 25—Miami Copper Co. reports high record production of 6,000,000 lb. per month, due largely to the unrestricted use of flotation, following the settlement of dispute.

DECEMBER

Dec. 2—Surplus copper in the Lake country reported depleted.
Dec. 2—Important underground developments reported at the American Boy Mine, at Sandon, B. C.
Dec. 2—Shutting down of carnotite mines in Colorado reported.
Dec. 6—American Petroleum Institute convenes at St. Louis, Mo.
Dec. 7—Report issued of Governor Stephens' committee on the Argonaut mine disaster, in which Bradshaw, the shift boss, and the management of the mine are censured.
Dec. 9—Purchase of the properties and interests of the Chile Copper Co., by the Anaconda Copper Mining Co., reported, thus bringing under one control extensive holdings in the copper-mining and fabricating industries.
Dec. 9—Several new concentrating plants started operations in the Joplin-Miami lead-zinc district.
Dec. 9—Price of arsenic products rises so rapidly that Congress takes action.
Dec. 11—Suit started by Pearce-Smith Converter Co. against the United Verde company, for alleged infringement of patent of E. A. Cappelen Smith.
Dec. 16—Butte & Superior reported declaration of dividend of 50c. per share, the first since 1917.
Dec. 16—Discovery reported of important lead deposits in Spain.
Dec. 23—Death reported of David Lindsay, explorer and discoverer of the West Australian gold field.
Dec. 23—Absorption by the Calumet & Hecla company of the Ahmeek, Allouez, Centennial, and Osceola mining companies is forecast as imminent.
Dec. 23—Successful leaching of copper ore in place in the mines of the Ohio Copper Co. reported.
Dec. 23—Merger of the Refugio, Hidalgo, and Alvarado companies, operating in the Parral district of Mexico, is forecast.

TECHNICAL DEVELOPMENTS

Mining Practice

Safety Projects—Mine Ventilation—Hoisting Rope—Underground Transportation—Rock Drills and Explosives—Mining Methods—Prospecting, Sampling, Ore Estimation—Open-Pit Mining—Miscellaneous

BY GEORGE J. YOUNG
Associate Editor, San Francisco

THE YEAR 1922 marked a recovery, in part at least, from the apathy that characterized 1921. Metal market revival was only partial, gold, silver, lead, and zinc maintaining and improving their price position, while copper fluctuated between narrow limits, too low in price to promote enthusiasm among the copper miners. The coal and railroad strikes proved that labor disturbances of national extent are still important factors. The period was one in which interest centered in economics and in the human element in industry rather than in details of practice. For many years engineers and mining men have been impressed with the objective in mining practice—the development of mechanical appliances, the perfection of mining plants, and the improvement of methods. The human element has been neglected, but its equal importance with mechanization and technical development is now conceded. The campaign for safety first has resulted in more thought upon the whole labor situation. Greater economic gains are possible in the direction of proper training, adequate compensation, and skillful handling of mine labor when adopted in conjunction with the application of the wealth of mechanical appliances and the knowledge of their use.

SAFETY IN MINE OPERATION

Three mine catastrophies attracted wide attention in the fall of 1922; the Argonaut, at Jackson, Calif.; the Reilly colliery, at Spangler, Pa., and the Dolomite No. 3 colliery, in the Birmingham, Ala., district. The fatalities were respectively 47, 77, and 84. The Argonaut disaster resulted from a fire in a downcast working shaft; the other two, respectively, were gas and dust explosions.

The result of the Argonaut fire was the drafting of a series of fire-control suggestions by the Mine Operators of California. These provided for four fundamentals: the fireproofing of downcast working shafts in an inflammable condition; the installation of fire doors at downcast and upcast shafts on all working levels in which local fire hazards occur; the provision for fire-fighting apparatus (water supply, hose, and extinguishers); the adequate planning by the mine management of methods for handling a fire emergency, and the training of a selected fire-fighting organization. Various supplemental suggestions were made,[1] which need not be detailed here. The suggestions in themselves are excellent and are worthy of careful study by mining engineers and operators. They avoid revolutionary changes and cumulative precautions, and provide for the wide variations in mining conditions that generally occur in the metal-mining states.

[1] *E. & M. J.-P.*, Vol. 114, p. 914.

Advance in the reduction in mine accidents has been made. B. F. Tillson[2] reviews the accident rate in the New Jersey zinc mines, and states that, per 1,000 shifts (eight-hour) worked, it has been reduced from 3.34 in 1912 to 0.42 in 1921; the hours lost per 1,000 hours worked were reduced from 17.15 in 1913 to 7.70 in 1921; the averages for nine years were, respectively, 0.68 and 7.65. John L. Boardman,[3] in discussing accident rates for the Anaconda group of mines, states that a steady reduction has taken place. He says that the total accident compensation paid by mining companies in 1919 was $2,946,830; and that, by including the value of the time lost, the total money equivalent was $4,821,020. This serves to indicate the economic importance of accident prevention. He epitomizes the situation by saying that the foreman becomes a teacher; it costs less to warn and instruct a workman than to criticize, disparage, or discharge him. Constant propaganda and suggestive teaching reduce accident rates. C. A. Allen,[4] in his discussion of Utah mine accidents, draws the conclusion that the workers are responsible for most of the accidents; that the presence of safeguards leads to carelessness of men; that proportionally fewer accidents occur in small as compared with large mines; that the efficiency and ability of the mine management is one of the decisive factors in accident prevention; that, since the passage of compensation laws, a marked increase in the number of minor accidents is reported. When labor is scarce and wages are high, accidents increase.

C. W. Goodale and J. L. Boardman[5] are of the opinion that fair treatment of workmen and consideration of their welfare, together with a limited number of pertinent rules and educational work for both foremen and men, are the important principles contributing to the reduction of accidents. Sincerity is the key to success, they wisely remark.

E. M. Norris[5] and H. J. Rahilly[6] contributed to the subject of fire prevention. In the Butte mines, the failure of electrical equipment was the principal cause of mine fires. Heavy, continuous timbering, ground movement, acid waters, and oxidation in old stopes containing large amounts of timber were the mining conditions which added to the prevalence of mine fires. Extensive fireproofing by means of "gunite," remodeling of electrical installations, the extension of the underground water system, and the development of efficient fire-fighting and fire-patrol crews were the steps taken to reduce the fire hazard and to extinguish incipient fires.

[2] *Min. & Met.*, 189, p. 57.
[3] *Ibid.*, 189, p. 33.
[4] *Ibid.*, 185, p. 32.
[5] *Ibid.*, 182, p. 38.
[6] *Ibid.*, 182, p. 42.

TECHNICAL DEVELOPMENTS

Thirteen copper mines in the southwest, in Arizona principally, have installed mechanical ventilation, according to C. A. Mitke.[7] This has been due in part to the necessity of fighting mine fires in sulphide orebodies. The increased efficiency of the workers in properly ventilated mines has been noted. As a consequence, the long supremacy of natural ventilation in metal mines is now a thing of the past. Ventilation by fans, enabling close control of air currents, is a vital part of modern metal-mining practice.

D. Harrington[8] advocates the use of a large fan for the control of the principal underground air currents. A position on the surface and non-combustible construction are recommended. Provision for the reversal of air currents is essential. The principal working shaft or adit should be downcast or incast. Abandoned workings should be sealed. He cites the Colorado mine, at Butte, where a ventilating equipment was installed at a cost of $70,000. A saving of $18,000 resulted from the diminished power required for compressed air. How much waste has resulted from ventilation by compressed air has never been computed, but undoubtedly the systematic ventilation of large mines by power-produced air currents will result in important reductions in expense in other directions, as well as increased efficiency of workers. A. S. Richardson[9] said that the quantity of air required in ventilation is not governed by the number of men underground. The quality of the air must be good and its temperature and humidity controlled.

W. S. Weeks has added to his contributions on the subject of ventilation by an interesting paper[10] on the selection of fans for pipe ventilation and the determination of friction factors for ventilating pipe. The development of flexible tubing for ventilating purposes, resulting in longer-lived tubing, has continued, and better grades are now available.

Hoisting Rope

R. W. Raymond[11] has found, as the result of investigation, that the majority of operators use ropes of the best materials and the 6x19 construction. Some flattened strand as well as Lang lay ropes are in use. Few companies specify materials, but all should detail the conditions under which hoisting ropes are to be used. Mr. Raymond advocates changing ropes on the hoisting drums from time to time. There is much diversity of practice in deciding when a rope must be discarded. Usually signs of internal corrosion and reduction in diameter due to wear are the criteria, although the prevalence of broken wires and time in service are also taken.

W. N. Tanner and J. C. Jaccard[12] state that round hoisting ropes are superseding flat ropes in the Butte district. J. F. Howe[13] says that 90 per cent of the hoisting ropes used in the United States are regular lay. Shaft ropes should never be spliced, but it is permissible to splice haulage ropes. Lack of familiarity in splicing Lang lay ropes is the reason for their slow introduction in the United States. The socketing of wire ropes by the use of zinc is advocated.

According to C. W. Woodward,[14] electric signaling is generally used in the Butte shafts. The station tender rides the cage when men and supplies are hoisted, and when ore is hoisted he is stationed at the skip pocket to load and dispatch the skips. Two signals are used: one for the station bells and the other for the shaft. A buzzer supplements both signals. When the buzzer signal is given, which sounds on all levels, the station tender is notified that he is wanted at some particular level. Pull switches are used for main signals, and all signals are in the same places at each station.

Underground Transportation

The growth of locomotive transportation underground is indicated by C. D. Woodward[15] in his paper on the practice in the Anaconda group of mines. He states that 185 trolley-type locomotives are in use, each of which has displaced five animals. Twenty-two storage-battery locomotives are also provided. There is little difference in the cost of operation. Track maintenance cost is in favor of the storage-battery locomotive.

R. T. Murrill[16] stated that large outputs necessitate a well-planned signal system for the handling of ore trains underground. He describes the block system, furnished by the General Railway Signal Co., in use in the Inspiration mine. C. E. Stewart[17] reviewed the advantages of storage-battery locomotives for underground service, and stated that they are now constructed so as to eliminate excessive maintenance costs.

In handling ore underground, H. R. Tunnell[18] states that the rill stope is growing in favor in the Butte district. The floors are placed on a 40- to 45-deg. angle, so that the ore runs to the lower end of the stope.

Rock Drills, Blasting, Explosives

The significant development of 1922 was the commercial introduction of the Hawkesworth replaceable drill bit.[19] This bit has been experimented with by the Anaconda Copper Mining Co. and has proved useful. It is ingeniously constructed and fastened to the shaft by dovetailed wedges. The replaceable part is made of vanadium steel. Just what its place will be in general mining practice remains to be determined. I venture to predict that it will find important use in medium-hard to soft rock drilling.

Drill steel to the amount of 6,500,000 lb. or more is consumed annually in metal mining. The importance of high-quality drill steel and proper heat treatment is conceded. The subject has been under joint investigation by the U. S. Bureau of Mines and the U. S. Bureau of Standards. A survey has been started, and a progress report[20] has been issued. This indicates a tendency to standardize on 1-in. round hollow steel and the prevailing use of oil-fired furnaces. Medium-hard to soft-rock mines have no acute drilling problem. No noteworthy additions to drilling machines were made during 1922. Royal J. Day described methods of testing rock drills.[21]

Interest has been stimulated in the subject of blasting

[7]Bull. A.I.M.E., Sept., 1922.
[8]*Min. & Met.*, 182, p. 39.
[9]*Ibid.*, 182, p. 40.
[10]*E. & M. J.-P.*, Vol. 112, pp. 816, 1001.
[11]*Min. & Met.* 182, p. 46.
[12]*Ibid.*, 182, p. 48.
[13]*Ibid.*, 182, p. 49.
[14]*Ibid.*, 182, p. 43.
[15]*Ibid.*, 182, p. 43.
[16]*Ibid.*, 182, p. 21.
[17]*Ibid.*, 181, p. 30.
[18]*Ibid.*, 182, p. 45.
[19]*E. & M. J.-P.*, Vol. 114, p. 262.
[20]*Ibid.*, Vol. 114, p. 68.
[21]*Ibid.*, Vol. 114, p. 317.

TECHNICAL DEVELOPMENTS

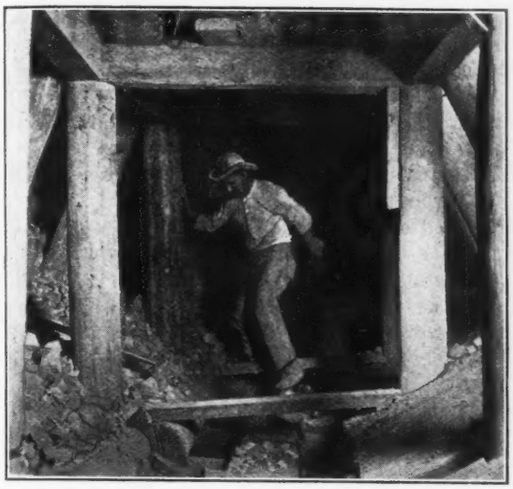

Fig. 1—Incline top slicing at Morenci, Ariz. Fig. 2—Edge of the timber mat. Top slicing operations

by the suggestive articles by B. F. Tillson,[22] and by the discussion contributed by E. L. Watts. Mr. Tillson has asked a number of critical questions, which have served to indicate the need for scientific investigation of blasting practice. Mr. Watts calls attention to developments of blasting caps and blasting machines and practice in their use. The electric blasting cap and delay exploders have won a place of no little importance. The placing upon the market of a high-amperage blasting machine is a significant step. Technique and equipment for electrical blasting are now in an advanced state and the requirements of the miner are fully met.

Diamond drilling continues to find a place of growing importance. In the Oatman district, Arizona, significant discoveries were made by its use. Frank A. Kennedy[23] described the use of the diamond drill in Idaho. At the Premier mine, in the Salmon River district, in British Columbia, the diamond drill was used to prospect formations. Diamond-drill equipment has been improved to the extent of developing internal-combustion units for use in new country. These have proved serviceable and provide a means for getting information quickly and cheaply as compared to underground work.

Mining Methods

Joseph P. Hodgson and John Kiddie presented[24] data on the comparative cost of incline and flat slicing methods as applied in the Humboldt mine, Morenci, Ariz. The incline slice (33 deg. inclination) was introduced in 1917 and was designed to reduce the amount of ore handling. The slicing floors are inclined and discharge into a hopper 4 ft. wide, which connects with vertical ore chutes placed on 15-ft. centers and on an axis at right angles to the direction of inclination. The ore gravitates to the hoppers and chutes, which are kept filled almost to the slicing level. Tons per man (including timbermen, helpers, miners, muckers, and hand trammers) were 5.4 for flat slicing and an average of 7.6 for incline slicing. Incline slicing required 9 bd.ft. of timber per ton and flat slicing 7.9 bd.ft. Costs were reduced 15 per cent in favor of incline slicing. The method may be said to have been thoroughly established.

The Spies open-stope method of mining was described by S. R. Elliott.[25] It is in use in the Spies iron mine of the Cleveland-Cliffs Iron Co. The ore is solid and tough, and will stand without caving. The walls are hard, and the dip is steep.

John R. Reigart[26] briefly described the methods used by the United Comstock Mines Co. at Gold Hill, Nev.

E. C. Henry[27] described the mining method employed in the Mineville district, New York. Little timber is required, and underhand stoping with ore pillars for support is the customary practice. Type O Thew shovels and Myers-Whaley loaders are in use.

General interest in mining methods, chiefly through the efforts of the committee presided over by John E. Hodge,[28] continued throughout 1922. Various classifications have been proposed; but, as classification is placing the cart before the horse, little progress has been made. When comprehensive data involving detailed descriptions of methods are at hand, a useful classification of mining methods can be worked out. A tabulation of working standards, tons per man, power per ton, and supplies per ton, together with the dimensions of average stopes and physical characteristics of orebody and wall rock, would be useful and should be evolved by the Institute committee.

Prospecting, Sampling, Ore Estimation

The need for systematic study of the rationale of prospecting has been championed by Augustus Locke and others. Undoubtedly the subject will be further developed and will result in organized search for mineral deposits by specially trained men. Electrical phenomena produced by metalliferous deposits continue to be investigated. C. and M. Schlumberger[29] state that "every mineral mass which possesses electrical conductivity for a sufficient vertical distance, and which is incased in the earth in such fashion that some of its parts are

[22] *Ibid.*, Vol. 113, pp. 105, 446.
[23] *Ibid.*, Vol. 113, p. 521.
[24] *Ibid.*, Vol. 113, p. 915.
[25] *Min. & Met.*, 183, p. 58.
[26] Bull. A.I.M.E., Sept., 1922.
[27] *Min. & Met.*, 191, p. 57.
[28] *E. & M. J.-P.*, Vol. 113, p. 298.
[29] *Ibid.*, Vol. 113, pp. 678, 870.

TECHNICAL DEVELOPMENTS

above the ground-water level, produces, in the surrounding wet rock, electrical currents which are detectable." Sherwin F. Kelly[30] has investigated the application of the Schlumberger method to American ore deposits. Ducktown, Sudbury, Cobalt, Porcupine, Kirkland Lake, Houghton, and other points were visited, and the method was experimentally tried out. Mr. Kelly states that "prospecting by electricity will probably find its most useful field in preliminary surveys of mineral districts for the purpose of determining the most advantageous locations for putting down diamond-drill holes. Professor Schlumberger's method gives one a general idea of the location and trend of mineral zones, but is incapable of discovering precise information as to the character and value of the metals present."

An unusual number of articles have appeared on the subject of sampling and ore estimation. E. C. Henry[31] discussed methods of iron-ore estimation at Mineville, N. Y. Three diamond-drill holes are located at an average distance of 738 ft. in advance of working ore faces. The average ore thickness in the face and as determined by the drill holes is taken and multiplied by the horizontal area. If diamond-drill cores show no diminution in thickness, 500 to 1,000 ft. in advance of drilling is reckoned as probable ore. R. W. Prouty and R. T. Green described[32] the sampling methods in use in the Copper Queen mine. The work is in charge of the geological department. A critical study of each orebody is made, its history, geological relationships, and present condition. Estimation is made by horizontal and vertical sections. A three-year ore supply is developed ahead of mining operations.

Advances in Sampling Practice

J. F. Wolff, E. L. Derby, and W. A. Cole[33] presented an excellent account of the practices in vogue in the Lake Superior iron-ore district. J. F. Wolff[34] discussed the practice on the Gogebic Range. Ira B. Joralemon[35] pointed out the desirability of combining sampling work with geological studies and costs in ore estimation of disseminated copper deposits. Anaconda practices in sampling were presented by W. B. Daly and F. A. Linforth[36]. W. F. Boericke[37] showed the inapplicability of ordinary sampling and estimation methods to the Wisconsin zinc and lead deposits. Visual examination by experienced operators gives surprisingly accurate results. However, he states that churn drilling is the most reliable method of sampling and estimating the orebodies. E. S. Berry[38] discussed present value of mines in relation to ore reserves, plant capacity, and grade of ore.

The use of core drilling in petroleum operations has become firmly established as a more satisfactory method for determining formations than methods in vogue. J. R. Suman[39] and F. C. Merritt[40] contributed descriptions of methods in use. The trend of practice indicated is toward more precision in methods, a coordination of geological information, and consideration of costs and marketing. The geologist has of necessity to adopt engineering methods and broaden his field by a study of economic data.

Open-pit mining was little discussed during 1922, chiefly because practice has settled down to routine. H. M. Ziesemer and George Mieyr[41] described in detail the excavation methods at Bisbee.

A combination of toe and bank holes is used to break the bank. Toe holes are drilled by machines, and bank holes by churn drills. Churn drills average 31.2 ft. per shift, at a cost of 35c. per foot. Bank holes are sprung to take a charge of 300 to 800 lb. of explosive.

Physiological effects of air movement in mines were investigated by the U. S. Bureau of Mines, but no new facts were developed. A. S. Sayers[42] investigated the effects of breathing carbon dioxide and carbon monoxide.

Miscellaneous Progress

Mine-camp sanitation is being studied as well as underground sanitation. The Bureau recommends the weekly washing and sterilization of water containers used underground where the source of the water is known to be pure, and daily washing and sterilization where the water is infected or its purity unknown. The use of chlorinated lime in small quantities for water purification is recommended. The use of geophones for locating leaks in compressed air mains was tried out, and it was found that large leaks could be readily detected. In the Argonaut mine fire, the geophone was experimented with in an endeavor to receive signals from the entombed men, but the results attained were inconclusive.

The subject of waste in mining received general consideration. Pope Yeatman[43] stated that the causes of waste in mining are:

1. Low production, caused by faulty management, of material, plant, equipment, and men.
2. Interrupted production caused by idle materials, idle plant, and idle equipment.
3. Restricted production intentionally caused by owners, managers, or labor.
4. Lost production caused by ill health, physical defects, and industrial accidents.

J. Parke Channing and W. R. Ingalls[44] contributed to the subject also. Mr. Channing advocated the establishment of standards of production and stated that the mine manager must be an engineer and that the mining engineer must have business experience. A great deal of waste in mining, he said, is due to financiers overequipping mining properties.

Standardization in mining received considerable attention in 1922. Much has been elucidated, and probably the resulting comparison of methods has been of value to mine operators. Vol. XXV of the *Proceedings* of the American Mining Congress contains an excellent digest of the subject. It is impracticable to review it in this article.

A notable contribution published during 1922 by the Bureau of Mines is the complete report on coal-dust explosion tests written by George S. Rice, L. M. Jones, W. L. Egy, and H. P. Greenwald.

[30] *Ibid.*, Vol. 114, p. 623.
[31] *Min. & Met.*, 191, p. 57.
[32] *Ibid.*, 191, p. 51.
[33] *Ibid.*, 189, p. 41.
[34] *Ibid.*, 189, p. 45.
[35] *Ibid.*, 182, p. 51.
[36] *Ibid.*, 182, p. 52.
[37] *Ibid.*, 182, p. 53.
[38] *Ibid.*, 187, p. 11.
[39] *Ibid.*, 190, p. 21.
[40] *Ibid.*, 188, p. 21.
[41] *Ibid.*, 182, p. 44.
[42] Serial 2931, U. S. Bureau of Mines.
[43] *Min. & Met.*, 193, p. 25.
[44] *Ibid.*, 183, p. 41.

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Milling and Flotation

Coarse and Intermediate Crushing Practice—Surface and Underground Plants—Mechanical Handling of Pulp—Developments in Concentrating Practice—Flotation Litigation and Technical Progress

BY ARTHUR F. TAGGART
Professor of Ore Dressing, School of Mines, Columbia University, New York

THE YEAR 1922 saw the reopening of most of the large copper plants, increased tonnage milled in lead and zinc plants, and top-notch operation of silver plants. In most cases, milling costs have been lowered. A departure in iron concentration was marked by the start of one unit of the projected 75,000-ton plant of the Mesabi Iron Co., at Babbitt, Minn. The litigation between Minerals Separation and the Miami Copper and Hayden-Stone group of mining companies over flotation processes was settled out of court. Experimental work on the treatment of oxidized ores has been unremitting. Leaching has given the most promising results in the treatment of copper ores, having been adopted by several operating companies. Volatilization and flotation divide the honors in lead- and silver-ore treatment, with no decisive successes to the credit of either. Many new mills have been built, one of which, that of the United Comstock Mines Co.[1] may well serve as the text for the following discussion, by reason of excellence of design.

DELIVERY OF ORE TO COARSE CRUSHERS

Wherever train transport is necessary, because of the distance between the mine and the coarse-crushing plant, the use of a revolving tipple or similar apparatus for unloading ore cars indicates the best practice. At the United Comstock the ore is hauled in 10-ton steel cars, which are dumped four at a time by such a tipple. At the plants of the Utah Copper Co. and of the Chile Exploration Co., 50- or 60-ton cars are similarly handled, but one at a time and by means of electric hoist unloaders. The cars are brought to a storage yard by standard locomotives and are moved on and off the receiving platform by gravity or by an auxiliary motor. At Ajo, on the other hand, following ordinary quarry practice, air-dump cars in the ore train are spotted one at a time at the primary crusher by locomotive. This method ties up the train crew during the time taken to pass the ore through the primary crusher, and does not lend itself to the use of ore cars for coarse-ore storage as do the Utah Copper and Chile Exploration systems.

DEVELOPMENTS IN COARSE-CRUSHING PRACTICE

Jaw and gyratory crushers of ever-increasing sizes are being used as primary breakers. At the United Comstock plant, the initial crusher is a suspended spindle gyratory; at Mesabi, the primary crusher is of the jaw type. These installations typify general practice. The gyratory crusher will crush more ore per dollar of capital expenditure and per unit of power than will the jaw crusher, if it is kept busy. In the gyratory crusher the ratio of capacity to width of receiving opening is much greater than in the jaw crusher. The difficulty, therefore, in gyratory installations is to supply the economic tonnage corresponding to the size of the receiving opening. The gyratory is properly used if the ratio of tonnage of feed to diameter of largest particles is great. This is usually the condition where large tonnages are produced by underground mining or in a milling plant, following the primary breaker. When the ratio of tonnage to diameter is relatively small, as is the case in quarrying or steam-shovel mining, the jaw crusher, which weighs less and consumes less power per square foot of receiving opening, is the more economical.

In a "Tabulation of Features of Eight New Flotation Plants"[2] it is shown that two out of the five plants using gyratory breakers have put in machines of the fixed-spindle type. This crusher has apparently come to stay. In its favor, as compared with the suspended-spindle machines, are greater ruggedness for given weights of metal and less plant head-room necessary for housing the crusher and handling repair parts. Power consumption per ton crushed through a given range is substantially the same in both machines.

UNDERGROUND COARSE-CRUSHING PRACTICE

Three underground crushing stations, each equipped with a 36x42-in. jaw crusher, have been built at the Ellison shaft of the Homestake Mining Co. These are just below the 800-ft., 1,400-ft. and 2,000-ft. levels, respectively. The crushers deliver the ore, broken to 4½ in., to 1,500-ton skip pockets. It would be interesting to see the engineering analysis that preceded the decision to build these stations. In a surface plant, the primary crushing would not have been done in three units, separated by several hundred feet, because of expensive operation. The cost of construction must have far exceeded that of a surface plant. As seen from this distance, the only element in favor of the scheme is the greater facility with which 4½-in. material can be loaded from a storage pocket into skips. It is possible that experience at the Homestake made this a compelling factor. The erection of a large underground crusher at the bottom of a glory hole is easier to justify. The large lumps of ore mined in open pits give trouble in the loading pockets, and a great deal of block-holing is necessary. Much of this trouble and the attendant expense can be avoided by placing a crusher of large receiving opening below the lowest point of the pit. But the description of Homestake practice[3] states that the crusher feed is trammed to the underground crushers, thus indicating that the rock has already passed through loading chutes into cars.

A variable-speed pan conveyor, under control of the crusher man, is used at the United Comstock plant.

[1]George J. Young, *E. & M. J.-P.*, Nov. 11, 1922.

[2]Arthur B. Parsons, *M. & S. P.*, Dec. 3, 1921.

[3]F. E. Wormser, *E. & M. J.-P.*, Oct. 28, 1922.

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With button control of motor starting and stopping, as now developed, this is probably the best possible coarse-crusher feeder. Its use recognizes the fact that, although there is no danger of stalling either jaw or gyratory breakers by burying them, yet in such practice the frequent bridging of rock in and above the crushing zone is costly; and, further, that batch feeding makes it impossible to watch for and remove tramp steel and waste before they enter the mill.

Intermediate Crushing

At the United Comstock plant, 72 x 20-in. rolls, followed by 54 x 20-in. rolls, each discharging to vibrating screens, break the crusher product to ball-mill feed size. The No. 3 mill at the Britannia mine, Howe Sound, B. C., is being similarily equipped. Disk crushers are used in other recent mills for similar service. In the design of the leaching plant of the Chile Exploration Co., 48-in. horizontal-spindle disk crushers displaced 72-in. rolls for a reduction from 5 to 1½ in., and, later, on test, 48-in. vertical-spindle disk crushers displaced 54 x 20-in. rolls for reducing 1½-in. material to ⅜-in.[4] Disk crushers are used at Ajo, to prepare ore for leaching, and it is claimed that for this service they are superior to rolls, because they produce less fines. It is doubtful, however, whether the difference in this regard is great. The disk crusher has the advantage over rolls in weight per ton of rock crushed, but ruggedness is sacrificed therefor. Adjustment to compensate for wear of crushing surface is easier to make with the disk machine. It must, however, be scrupulously guarded against tramp iron, and is not capable of handling the overload that can be borne by rolls that are powerfully motored. There is more experience behind the building of large rolls. The choice between rolls and disk crushers for intermediate crushing, however, is one on which an engineer cannot go far wrong.

An unusual intermediate-crushing machine is found in the geared corrugated rolls at the Hollinger mill, which are 40 x 20 in. and run at 110 r.p.m. They take the product of two sets of gyratory crushers set at 1½ and 2½ in., respectively, and are set to discharge at ¾ in. In such service, one set of rolls handles 125 tons per hour, with a consumption of 45 hp.

Stamps as intermediate crushers have not as yet disappeared from new construction, wrong though such a choice may appear to most engineers. The new South mill at Homestake uses 1,550-lb. stamps to reduce gyratory-crusher discharge, 3-in. maximum size, to rod-mill feed.[5] The conclusion reached as a basis for design of the enlarged mill at the Hollinger was that ball mills are better than stamps in small plants; but that, in large plants and with hard ores, stamps and tube mills are preferable.[6] If the feed is coarse-crusher product, the Hollinger conclusion may be justified. The ball mill is not the "one easy step" from crusher product to slime. But as a link in a chain of crushers reducing run-of-mine rock to a size suitable for cyanide treatment or fine concentration, there seems to be no adequate evidence to support the selection of stamps. It is interesting to note that, even in South Africa, the stronghold of the gravity stamp, in the new mill of the New State Areas Co.[6] disk crushers have displaced stamps preparing feed for tube mills.

[4] A. W. Allen, *M. & S. P.*, Dec. 17, 1921.
[5] P. A. Robbins, *E. & M. J.-P.*, June 24, 1922.
[6] *E. & M. J.-P.*, June 17, 1922.

Ball mills, rod mills, and short tube mills hold the field for fine crushing. At the United Comstock plant, 7 x 6-ft. cylindrical ball mills and 5 x 11-ft. tube mills are used to grind for cyaniding. At the Santa Barbara lead-carbonate mill,[7] 5 x 10-ft. rod mills are used to reduce ½-in. material to 50 per cent through 2 mm. In Mr. Parsons' tabulation of flotation-plant practice, previously cited, three plants are using cylindrical ball mills; two, conical ball mills; two, short tube mills; and one plant is using a rod mill. The consensus of present opinion seems to be that a ball mill is preferable to a rod mill if the feed is sufficiently coarse to require impact to break the larger particles, or if a product containing as high a proportion of slime as possible is desired; that the rod mill is to be preferred when feed is relatively fine, and when a granular, slime-free product is sought; that for all-sliming, the short tube mill in closed circuit with a mechanical classifier is as efficient in producing fine material and much more economical in use of power than is the long tube mill.

Constant experimentation continues to determine the relative merits of series and parallel arrangement of ball mills. Valuable information on this subject, confirming the advantage of the series arrangement, was given in a paper[8] recently read before the Canadian Institute of Mining and Metallurgy. In a beautiful series of high-speed instantaneous and moving-picture photographs, Haultain and Dyer show that at the speed necessary to get the free fall of balls essential to crushing coarse-ore particles there is distinct segregation of fine particles at the periphery of the mill. The pictures also show that crushing of fine particles is accomplished principally by the rubbing together of the balls, brought about by differential slip in the ball load. Maximum effectiveness of fine grinding, therefore, will be attained when there is a thorough diffusion of pulp throughout the ball load. This condition is found at a speed at which there is little or no free fall of balls. As the speed is reduced below this point, segregation again occurs; but this time the fine material tends to collect in the center of the ball load. These facts explain why the arrangement of ball mills at Miami has proved the most effective. At this plant, three 8-ft. conical mills per section crush 1,250 tons per day of roll product, through ¾-in. screen, to flotation size; the total tonnage passes through the first mill and is discharged into a Dorr classifier, which overflows direct to flotation. The sand is divided between the other two mills, which discharge each to its own Dorr classifier, operating in closed circuit, the overflow going to the flotation cells.

Recent Practice in Pulp Elevation

An increasing disinclination to use bucket elevators in any part of the mill is noticeable. The latest coarse-crushing plants are designed to use belt conveyors. This does away with the clogging inseparable from the use of bucket elevators handling coarse ore, and has a second advantage in that it allows the use of the traveling crane in all parts of the coarse-crushing plant.

Centrifugal pumps and spiral sand pumps have for several years been displacing elevators in handling fine-sand and slime pulps, and this movement has been accelerated by the recent introduction of the Wilfley

[7] F. M. Heidelberg, *E. & M. J.*, Dec. 31, 1921.
[8] H. E. T. Haultain and F. C. Dyer, *Bull.* C. I. M. and M., June 1922.

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sand pump. This device is a centrifugal pump with adjustment for taking up, while running, the wear between runner and shell, thus eliminating the principal cause for low efficiency in the handling of pulp by the ordinary centrifugal pump. It is also constructed so as to allow the easy and quick replacement of worn shell liners and runners.

Air lifts have been adopted recently at several plants where large volumes of pulp have to be handled. The largest installation is that at the plant of the Chino Copper Co.,[9] which has been designed to lift 12,000 tons of ore per twenty-four hours for a vertical height of 40 ft. On the basis of sixteen months' performance, handling 5,000 dry tons per day, the average efficiency reckoned on total horsepower was 32.2 per cent, and the cost just over 50 per cent of that of bucket elevators handling an equal tonnage of similar pulp.

It is worthy of note that the tendency toward individual motor drives, so marked in recent years, persisted and even increased in 1922. In one mill this practice has been extended to concentrating-table drives. Along with this change in procedure has gone a change in method of transmission. Low-speed direct-connected motors, herringbone gears, inclosed-gear speed reducers, and chain drives have displaced belts and pulleys to an amazing extent; and, even where belts are retained, the Lenix drive has been substituted frequently for the ordinary countershaft system. The result of this change is to leave the upper part of mill building free for the installation of cranes, so that repairs, particularly to heavy machinery, can now be made more promptly and at a small fraction of the former cost.

Present Attitude Toward Gravity Concentration

The year 1922 witnessed a reaction from the extreme position taken a few years ago that tended to exclude gravity concentration entirely from mills treating ores amenable to flotation. It is becoming recognized after bitter experience that flotation is far from being the universal cure for concentration ills. Analyses of losses in flotation tailing have shown that most of the valuable mineral is in the coarsest and in the finest sizes. Tables following flotation machines will save much of the coarse mineral at a trifling cost, particularly if the slime has been taken from the table feed. The fine mineral is beyond saving, as far as present knowledge goes; but in some cases the amount of such in the tailing has been lessened by gravity concentration before flotation. If there is much sulphide mineral in the ore, it will probably pay to treat a part, at least, by gravity concentration before flotation; and in many if not in most mills the desliming of flotation tailing, followed by tabling of the sands, should yield a profit.

Settlement of Flotation Litigation

On the initiative of the Minerals Separation company, the suits against Miami Copper Co., Butte & Superior Mining Co., Utah Copper Co., Chino Copper Co., Ray Consolidated Copper Co., and Nevada Consolidated Copper Co., for infringement of one or more of patents Nos. 835,120, 962,678, and 1,099,699, were settled out of court in the early part of 1922. The settlement consisted in the taking of licenses by the mining companies on a graduated royalty basis, the contracts dating from Jan. 1, 1922, and payment of lump sums, approximating roughly graduated royalty totals, to cover prior operations. Minerals Separation waived any advantage that lay in the possibility of collecting from the Miami and Butte companies, in the accounting proceedings under the Philadelphia and Supreme Court decisions, respectively, profits or punitive damages amounting in total to several million dollars above the back royalties collected from all the companies.

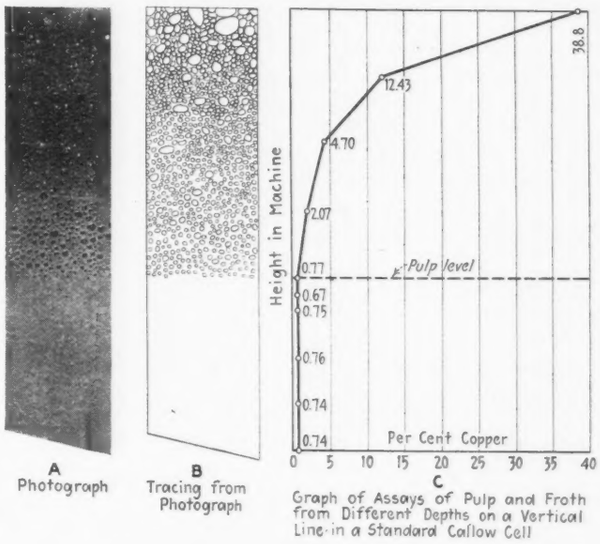

Fig. 1—Chart showing place of concentration in bubble-column flotation

The compromise was probably a good thing for both sides, from the business point of view. It relieved the mining companies of the uncertainty inherent in litigation, and from the threat of the punitive assessment. Not the least of the advantages accruing to the Minerals Separation company is the fact that the settlement will probably cause many small operators to join the present licensees. For those operators that use pneumatic flotation, the settlement seems deplorable. Their reading of the controlling decisions cannot have failed to show them that there is no clear and unequivocal holding that places pneumatic flotation within the scope of the patents; indeed, the plain intent of the decisions would seem to be to limit the claims to operations employing agitation of such violence as effectively to introduce air and produce flotation. From the physical point of view, such agitation is markedly different from the relatively gentle swirling in a pneumatic cell, and the mechanics of the resulting flotation are entirely unlike in the two cases. The following paragraph details experiments leading to this conclusion:

Figures *1 A* and *2 A*, respectively, are photographs of what may be seen by observing the action in a pneumatic cell and in the spitzkasten of an agitation-froth machine. Figures *1 B* and *2 B* are tracings from the adjacent photographs. In the pneumatic cell, the color of the bubble loads directly above the pulp surface is the same as that of the pulp itself, showing that up to this point no concentration has taken place. Upward through the bubble column there is a gradual color

[9] H. G. S. Anderson, *E. & M. J.*, Nov. 19, 1921.

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change to that of the cell concentrate, reached in the overflowing layer of bubbles at the top. This progressive color change indicates that progressive concentration is taking place in the bubble column itself. The visual impression thus gained is confirmed by the assays on the chart, Fig. *1 C*. These results are typical of a large number of determinations made in operating cells in many mills with many different ores. They show clearly that the bubbles emerging from the pulp in the cell carry a load of pulp, not concentrate; that no selection of valuable mineral from gangue has taken place in the body of pulp in the cell, but that any selection occurring takes place in the column of bubbles above the pulp surface.

The mechanics of this concentrating action in the bubble column is clearly visible, with a little practice in observation with a hand glass, through the sides of a glass-walled cell. Such observation shows that the mass of solids in the bubble column is constantly draining downward in the bubble walls; that in this movement there is segregation of the minerals; that the metallic minerals hug the bubble surfaces more closely than do the gangue minerals and are slightly more retarded in passing from one bubble to the next below, so that they not only travel a longer path than do the gangue minerals but travel at lower velocity. The bubbles travel upward at an average rate greater than the average falling rate of the metallic minerals and less than that of the gangue. The net result is concentration.

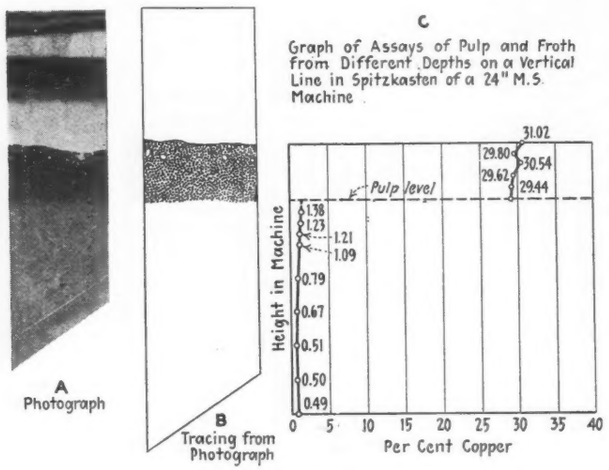

Fig. 2—Chart showing place of concentration in agitation-froth concentration

In photograph *2 A*, on the other hand, a clear line of color demarcation occurs at the surface that separates pulp from froth, and the color of the froth is substantially the same from bottom to top. The visual difference is confirmed by the assays given on the chart, Fig. *2 C*, which show that the bubbles in the agitation machine emerge from the pulp with a load of metallic mineral that has been concentrated at their surfaces *in the body of pulp;* and, further, that there is little if any concentration in the froth layer itself. The mechanism of concentration in this process is the same in kind as that in the Potter, Froment, and Elmore vacuum processes; there is a selective precipitation of gas at the metallic-mineral surfaces from solution in the water of the pulp. It differs from the processes mentioned only in the means of effecting the gas precipitation. The general mechanism of all of these pulp-body processes is most readily studied by means of a vacuum apparatus.

If an oiled pulp, deslimed to aid observation, is placed in a vacuum cell so constructed that the mineral particles can be observed through a low-power microscope (10 *X*), when vacuum is applied it will be seen that gas precipitates rapidly at the surface of the metallic-mineral particles, forming adherent bubbles, whereas little or no gas precipitates on the gangue particles. Soon the gas-mineral aggregates float to the surface, and concentration is thus effected. Investigation of the behavior in the pulp in the Potter and Froment processes shows similar selective precipitation; but in these processes an additional phenomenon is to be observed; the gas bubbles evolved from carbonates will rise slowly through the mass of solids, pushing gangue and metallic-mineral particles indiscriminately out of the way, but not adhering to either. This shows that adherence of bubbles to mineral particles in the pulp is not brought about by simple contact. The condition of gaseous supersaturation necessary to cause precipitation in the agitation-froth process is created by the agitation itself. Measurements made in my laboratory have shown a vacuum equivalent to 16 ft. of water behind the impellers of a laboratory agitation machine arranged to prevent the introduction of air. At this speed the water in the machine was milky, by reason of air beaten out of the solution.

Soluble Frothing Agents

It is worthy of note, in view of the fact that Patent 835,120 expires in November, 1923, that the name applied to this patent—the insoluble frothing-agent patent—is a misnomer. No agitation-froth flotation has ever been performed with an insoluble agent; the oil used has always necessarily contained a soluble fraction.[10] Such a state of facts, coupled with the published[11] use, in froth-flotation concentration prior to May, 1907, of tars and coal-tar creosote in quantities less than 1 per cent of the weight of the ore, should preclude extension of the present patent monopoly beyond 1923.

Flotation of Oxidized Ores

Leaching followed by flotation of the precipitated metal as metal or sulphide, or sulphide filming of the oxidized metallic minerals, are the two lines along which experimentation was most active during 1922. The solution of the metal and the flotation of metal precipitate are relatively simple operations; flotation of precipitated sulphide is more difficult, and successful precipitation of copper metal in the flotation pulp has not yet been practiced in full-scale operations at any mill, if production of the precipitating agent is included as part of the problem. The Chino Copper Co. is reported to have experimented successfully on a commercial scale, using, as a precipitant, sponge iron made from magnetite concentrated from the mill tailing, and to have solved the problem of the commercial production of the iron.

[10]Taggart and Gaudin, *Mining and Metallurgy*, August, 1922.
[11]A. S. Elmore, *E. & M. J.*, May 11, 1907.

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Hydrometallurgy

Gold and Silver — Copper — Lead — Zinc — Iron — Nickel

By Rudolf Gahl
Consulting Metallurgist, 804 Equitable Building, Denver, Colo.

PERHAPS THE MOST important event in the metallurgy of gold and silver in 1922 was the completion of the new South Mill of the Homestake company. No deviation has been made from the metallurgical methods that have proved so successful in the past, but rod mills will relieve the stamps of part of their load.[1]

Construction is under way on a large all-sliming cyanide plant on the Witwatersrand, at the New State Areas mine. Amalgamation is not to be practiced. Symons horizontal disk crushers and exceptionally large tube mills will be used. Brown (Pachuca) agitators, Butters filters, sand clarifying tanks, Merrill precipitation presses, in combination with Crowe vacuum equipment, characterize the plant. Means are provided for continuously removing and breaking pebbles after they are worn down to a size under which they are apparently of no further use.[2]

Much interest has centered on the newly constructed mill of the United Comstock Mines Co., in Nevada. An essential step in the process employed is the preliminary washing of the ore in Akins machines. This reduces the consumption of cyanide and lime and hastens the settling of the ore. Four different products are made by classification and concentration: primary slime, secondary slime, sand tailing, and sand concentrate. The two classes of slime undergo agitation and filter treatment, as does the concentrate after regrinding; the sand tailing is leached by percolation. The primary slime, which is of a higher grade than the secondary slime, receives a proportionally more elaborate treatment. The treatment of the concentrate, for the same reason, is still more elaborate. Moore filters are used. The ore is low-grade and not easily cyanided. Nevertheless, those who are responsible have succeeded in finding a cheap treatment that makes it possible to extract the precious metals. The plant has been described fully by George J. Young.[3]

Precipitation by Charcoal

At the San Francisco meeting of the Institute in September, 1922, a paper by J. Gross and W. Scott, on charcoal "precipitation" of cyanide solution, presented results of a research suggested by A. W. Allen and confirmed the conclusions previously published by him in the technical press and in the third edition of Julian & Smart's "Cyaniding Gold and Silver Ores." The impoverishment of the solution, in the light of these investigations, is due to adsorption.

An editorial in the *Journal-Press* of May 27, 1922, dealt with tests made by Dr. W. J. Sharwood with a special charcoal obtained from the burning of seaweed in California, termed kelpchar. It was stated that the tests demonstrated that this material is an efficient substitute for the metallic precipitant ordinarily used.

Precipitation methods with zinc have reached so high a state of perfection that they might well affect the leaching procedure in cyanide practice. It seemed necessary in the past to carry more than a certain minimum of free cyanide in the solution entering the precipitation plant; and a considerable percentage of the cyanide required for the leaching—sometimes all of it—was added at that point. This was necessary in order to obtain good precipitation. If, however, under the changed conditions resulting from improvements in practice, the highest extraction with a minimum consumption of cyanide is desired, the solution should be as low as possible in free cyanide at that point, and should be at a maximum where it is in contact with the almost exhausted ore. In other words, countercurrent leaching should be practiced. I am not referring here to countercurrent washing, as applied, for instance, by the Dorr Co., but to countercurrent leaching. Applied to decantation treatment of slime it would mean various agitations alternating with decantations, the first one with the lowest-strength and the last one with the highest-strength cyanide solution. Such a procedure would correspond to one that I found useful for the treatment of copper ores, and described in a paper read before the Electrochemical Society (Vol. 25). Y. E. Rothwell and H. B. Lowden also advocated such a system.

The regeneration of cyanide solution by acid has often been proposed. A promising process seems to be the one patented by L. D. Mills and T. B. Crowe (U. S. Patent 1,387,289), according to which the gases resulting from the acid treatment are removed, by drawing air through a porous diaphragm and through the solution, and are dissolved in an alkali.

Cyanidation of Refractory Ores

The Caron process was designed for ores that contain silver in combination with manganese insoluble in cyanide. The process has lately been adopted by the U. S. Smelting, Refining & Mining Co., and has been pronounced a commercial success.

I had the opportunity during 1922 to experiment in South America with a highly refractory ore, containing copper. The silver present is largely insoluble in cyanide; it occurs in a mixed siliceous and limonite gangue. Simple heating to a temperature of, say, 250 deg. C. improved the solubility in conformity with statements made by B. L. Gardiner and Paul T. Bruhl.[4] According to these investigators, the heating of a gold ore occurring in a limonite gangue, termed baking, improves the extraction by cyanide. In my experiments, still better results were obtained when the heating was carried to a temperature of about 400 deg C., in the presence of a small amount of pyrite. A high cyanide consumption was caused by the copper and

[1] F. E. Wormser, *E. & M. J.-P.*, Oct. 28, 1922.
[2] *South African Mining & Engineering Journal*, April 8, 1922.
[3] *E. & M. J.-P.*, Nov. 11, 1922.
[4] *M. & S. P.*, July 17, 1920; Oct. 20, 1920.

TECHNICAL DEVELOPMENTS

by cyanicides formed during the heat treatment, but this could be kept down to a reasonable amount by a preliminary leach with dilute acid. The beneficial effect of the pyrite was probably due to a sulphating action, caused by its decomposition; roaster gases containing about 2 per cent SO_2, by volume, had the same effect as pyrite and insured a lower cyanide consumption.

I have referred to an acid leach previous to cyanidation. This has often been recommended, but seldom, if ever, has been a commercial success. It is worthy of note, therefore, that a preliminary acid wash has been introduced as part of the regular treatment in the Nipissing high-grade mill, according to an editorial in the *Journal-Press* of June 17, 1922.

A summary of the progress in the hydrometallurgy of gold and silver would not be complete without referring to the fact that a considerable amount of precious-metal ore is being handled by the Longmaid-Henderson process in the Eastern installations of the Pennsylvania Salt Manufacturing Co. and those in Utah, using the Holt-Dern furnace.

HYDROMETALLURGY OF COPPER

Lately, the Copper Queen Branch of the Phelps Dodge Corporation has made preparations for heap leaching on a commercial scale, according to an article by Joseph Irving,[5] who has studied and applied heap leaching methods in many parts of the world. The early work of the company, largely experimental, was on a small scale. Although a 1,000-ton heap appears large, the operations involved are insignificant, several years being required to extract the copper. Various other companies are considering this system of leaching, among them the United Verde and the Chino Copper.

P. R. Middleton[6] reports interesting results by roasting Burro Mountain ore in a small ten-hearth Herreshoff furnace. He concludes that, under the conditions in question, it is cheaper to leach and to precipitate copper than to treat it by flotation and smelt the concentrates. N. V. Hybinette, in U. S. Patent 1,407,420, outlines a special combination of roasts for the purpose of converting the copper contained in ores into soluble form. He proposes to roast and to leach the ore twice in succession, and to electrolyze the resulting solutions. Before the second roast, the ore is treated with a salt solution, which helps subsequent operations.

Mr. Middleton has patented a process that utilizes ferric salts as the lixiviant (U. S. Patent 1,403,516). A moist charge is prepared with a solution of cupric or ferric chloride, and chlorination is performed by heating. The same investigator also has discussed[7] recently the application of ferric salts. To two statements made by him, L. E. Roberts, G. S. Tilley, and O. C. Ralston took exception.[8] The first point in the controversy is essentially theoretical; it hinges on the question whether ferrous sulphate is or is not a solvent for cupric oxide. As they point out, it is not, and becomes one only when, in consequence of oxidation, it changes to ferric sulphate. The other objection which Roberts, Tilley, and Ralston offer is that the suggested oxidation of ferrous to ferric sulphate by injection of air takes place so slowly that efforts to apply it commercially have failed.

The introduction of SO_2 into the leaching solutions has, contrary to expectations, proved a help to the oxidation of ferrous sulphate. In this manner it is explained by Bureau of Mines officials that, by returning the ferrous sulphate solutions (resulting from precipitation on iron) to the leaching drum in which they made SO_2 leaching experiments, the extraction has been improved. It is now said to equal that obtainable by ordinary sulphuric-acid leaching.[9]

The Miami Copper Co. now favors the use of sulphuric acid, having been influenced, it is reported, by the results of leaching experiments at Inspiration. This change of front took place, however, before the Bureau of Mines recognized the value of iron salts, which are held to be of great importance.[10] The Arizona Copper Co. had built a leaching plant along the lines advocated by the Bureau of Mines, which, however, was shut down when the Phelps Dodge Corporation took over the property, because of the conditions of the copper market.[11] Joseph Irving, Jr., has conducted experiments with SO_2 leaching on Nevada Douglas ore.[12] He classifies the ore and treats coarse and fine separately.

No important changes were made during 1922 at Chuquicamata, except in regard to the composition of the anodes. The Ajo plant was described in a series of articles by A. W. Allen.[13] Original practice has been retained. Several companies with similar problems are inclined to copy it. Tests at Inspiration have apparently shown that it is well adapted to the treatment of Inspiration oxidized ores; that even better results are possible at Inspiration than at Ajo. For instance, the copper in the waste solution could be recovered electrolytically at Inspiration.

The Miami Copper Co. is said to be considering leaching the ore with sulphuric acid, after reduction to 48 mesh, the present milling size. If electrolytic precipitation is to be used, this would mean filtering; and, if I am correctly informed, experiments along this line have been carried out.

William E. Greenawalt has made some tests for the Mountain Copper Co. with his leaching process, the ore being roasted beforehand. The copper was not so soluble as desired, but the only objection that could be raised against the process was its installation cost.

The presence and formation of ferric sulphate during electrolysis limits the quantity of copper that can be removed in one cycle. Investigations by the Pacific Experiment station of the U. S. Bureau of Mines, made by G. S. Tilley under Mr. Ralston's direction, indicate that ferric sulphate may be removed easily by precipitation with finely ground limestone, and that the precipitate is almost free from copper. To this end it is necessary to maintain a certain degree of basicity, which Mr. Tilley measures with an oxygen-test electrode. H. W. Morse[14] has outlined his views on the treatment of mixed sulphide-oxide ores of copper.

The Bardt process created a stir in Chile during 1922. Sawdust is reported to be the precipitant. As

[5] *E. & M. J.-P.*, April 29 and May 6, 1922.
[6] *E. & M. J.-P.*, April 15, 1922.
[7] *E. & M. J.-P.*, Sept. 9, 1922.
[8] *E. & M. J.-P.*, Oct. 21, 1922.
[9] *E. & M. J.-P.*, June 24, 1922.
[10] *E. & M. J.-P.*, Sept. 30, 1922.
[11] *Chem. & Met.*, Nov. 15, 1922.
[12] *E. M. J.-P.*, Aug. 26, 1922.
[13] *E. & M. J.-P.*, June 3, 10, 17; July 29, 1922.
[14] *Min. & Met.*, Sept., 1922.

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William E. Greenawalt has pointed out,[15] the use of similar reducing agents for the precipitation of copper is not new; sawdust was mentioned by Jumau in his patent (U. S., 930,968, Aug. 10, 1909).

The treatment of oxidized or semi-oxidized ore with sulphuric acid, followed by the addition of iron and the flotation of the copper, was discovered by many of us. In recent patent litigation,[16] priority has been awarded to M. F. Webster.

The manufacture of sponge iron in continuous operation, apparently a simple problem, seems to have presented difficulties, now overcome; for the Chino Copper Co. has a five-ton furnace in operation, and is reported to obtain results that are successful, metallurgically and economically.

The manufacture of copper articles from leach solutions seems to be still in the experimental stage, although seamless copper tubes and automobile radiators are being produced. H. A. Tobelmann, formerly metallurgist of the New Cornelia Copper Co., reports that progress has been made in depositing sheet copper in various fabricated forms directly from refinery, leach, and special copper solutions, and that the possibilities are promising.

HYDROMETALLURGY OF LEAD

Hydrometallurgical lead practice in the United States has been confined to electrolytic refining. Mixed lead-silver ores have been treated in several places, and the lead has been extracted with the silver, but the methods proposed for the precipitation of lead (electrolysis and precipitation by lime) apparently were not carried out. It is intended to utilize at one or two plants in Utah, using the Holt-Dern furnaces, the fact that lead can be precipitated from brine solutions by sponge iron. This will be the first application of hydrometallurgical methods for the commercial production of lead.

HYDROMETALLURGY OF ZINC

The recent patent literature contains descriptions of various processes devised by F. E. Elmore for the treatment of complex lead-zinc sulphide ores. According to one of these, the powdered ore is heated with sulphuric acid. Galena is changed to lead sulphate and is dissolved by brine solution, the zinc blende being unaffected. Tests made with the process seem to have confirmed this statement in a general way, but it was found that the blende is also attacked, which complicates the problem.

Tests are being conducted at Denver with the Coolbaugh process, and plans are being made for an installation at one of the smelters of the American Smelting & Refining Co. The roasting patent issued to M. F. Coolbaugh (U. S. Patent 1,315,761) seems only to have formed the starting point for the evolution of a sulphating roasting process,[17] in which the author was associated with J. B. Read and O. A. Fischer.

Motohiro Namba[18] suggests a novel utilization of low-grade zinc solutions resulting from the leaching of ores containing zinc. The solutions are treated with milk of lime. The precipitate that would be expected to contain calcium sulphate can, according to Namba, be kept free from it, if the fact is utilized that calcium sulphate has a tendency to form super saturated solutions. J. Field[19] has published a detailed description of electrolytic zinc-refining processes.

HYDROMETALLURGY OF IRON

Activity has been displayed in developing methods to be used in connection with the hydrometallurgy of iron. Carle R. Hayward wrote during 1922 on the extraction of nickel and alumina from Cuban iron ore,[20] describing experiments conducted for the purpose of removing impurities that reduce its value as a marketable product. He also made experiments that led to the establishment of the Eustis process for the manufacture of electrolytic iron directly from ore. The process should be called the Eustis-Perin process, to distinguish it from another process formerly proposed. Various papers deal with this method, among which may be mentioned the article by C. P. Perin and Donald Belcher,[21] and others by Bradley Stoughton.[22] An experimental unit for the manufacture of iron directly from ore is, or was, operated by the Consolidated Mining & Smelting Company of Canada, at Trail, B. C. Patents for the extraction of iron from ores have lately been granted to Arthur J. Moxham (U. S. Patents 1,420,127, 1,420,128, 1,420,129, 1,420,130, all of June 20, 1922).

The direct production of tubes seems promising; it is carried out in Europe on a commercial scale. Electrolytic deposition has also been applied for building up worn or undersized parts, as described in a paper by David R. Kellogg.[23]

HYDROMETALLURGY OF NICKEL

Electrolytic nickel refining is used exclusively at the plant of the British America Nickel Corporation, Ontario, Canada. The electrical equipment is described by J. L. McK. Yardley.[24] The ore is smelted to a nickel-copper matte, which is then roasted and leached with acid for the removal of most of the copper. Anodes are cast from the residue and put into the refinery cells, where the nickel precipitates on the cathodes, due to the fact that the copper contents of the electrolyte are continuously cemented out. Anode scrap takes the place of the iron ordinarily used in similar cases. The process is the work of N. V. Hybinette, who previously used it in Norway.

A serious impediment to the progress of hydrometallurgy, at least to those processes that require sulphuric acid, has been the high installation cost of acid plants. The paper by E. S. Larison[25] shows the reduction in investment and operating costs that can be made by the utilization of the Anaconda packed-cell type of plant, in place of an acid plant with the ordinary lead chamber.

Every hydrometallurgist will note with pleasure how the scope of the art has broadened in recent years. Everyone of us remembers the time when cyanidation and electrolytic copper refining formed the only applications of wet processes. It would seem that the technology of hydrometallurgy would soon overshadow that of pyrometallurgy.

[15] *E. & M. J.-P.*, Oct. 7, 1922.
[16] *E. & M. J.-P.*, March 4, 1922.
[17] *E. & M. J.-P.*, Aug. 19, 1922.
[18] *M. & S. P.*, March 4, 1922.
[19] *Trans.* Faraday Soc., Feb., 1922.
[20] *Chem. & Met.*, Feb. 8, 1922.
[21] *Min. & Met.*, Dec., 1921.
[22] *Iron Age*, Jan. 5, 1922, and *Chem. & Met.*, Jan. 18, 1922.
[23] *Min. & Met.*, Feb., 1922.
[24] *E. & M. J.-P.*, Nov. 4, 1922.
[25] *E. & M. J.-P.*, April 22, 1922.

TECHNICAL DEVELOPMENTS

Pyrometallurgy

Roasting Practice—Sintering—Chloridizing and Sulphatizing—Coolbaugh Process—Pulverized Coal—Complex Ore Problems

By Edward H. Robie
Assistant Editor

ADVANCES HAVE BEEN MORE MARKED in hydrometallurgy than pyrometallurgy during the last year, but nevertheless a few steps forward have been taken in the last-named field.

A pronounced advance in the design of roasting equipment seems to have been made in the so-called Ord roasting process (U. S. patent No. 1,362,408, issued to Carl S. Fogh and assigned to the Ore Roasting Development Co., of Philadelphia.) This was tried out on a commercial scale at the plant of the National Zinc Separating Co. at Cuba City, Wis., during the year, zinc blende concentrates being roasted down to less than 1 per cent of sulphur on minus 60-mesh material without the use of extraneous fuel. To secure this result, a furnace of the ordinary Wedge type is modified to allow some of the dried, hot, but unroasted ore from the second hearth to be bypassed directly to certain lower hearths except the last. The amount is so regulated that even and high temperatures are secured on four or five hearths instead of on one or two, thus driving off much more sulphur than is otherwise possible.

The American Zinc, Lead & Smelting Co. is building a furnace of this type at Columbus, Ohio, but an extra hearth will be provided at the bottom to allow time for as complete volatilization of sulphur as possible on the coarser particles of the charge. The process promises to have wide application.

In Australia, Rigg, of the Broken Hill company, has developed the blast roasting and sintering of zinc sulphide ores without the use of extraneous fuel except the ignition fuel on the second or sintering stage. The product gives excellent recovery in the retorts, and a shorter distillation period. Hegeler has been working on a pre-coked charge which partly eliminates the dilution of retort gases, forms less blue powder, and increases the capacity of the retorts. Improvements in continuous roasting, using the Ropp furnace, have been made in the East St. Louis plant of the American Zinc, Lead & Smelting Co.

Roasting furnaces are now available that, because of the use of heat-resisting alloys and coatings, will withstand higher temperatures than formerly. Dwight & Lloyd sintering machines are now being made in larger units, with capacities of 300 tons per day and more. Sintering of minus 300-mesh magnetic iron concentrate at the plant of the Mesabi Iron Co. is a success.

Much attention has been devoted to chloridizing and sulphatizing roasting, most of the work being in connection with subsequent leaching, and on an experimental scale. The commercial plant of the Pope-Shenon company, in Idaho, has been closed down, presumably proving a failure. The work of the Western Metallurgical Co. at Humboldt, Ariz., on volatilization and subsequent precipitation of the fume by the Cottrell process, is continuing, and the method will probably be proved soon in a large plant. Minor improvements to the very successful Cottrell process continue to be made and more attention is being paid to the proper conditioning of the gas.

The Coolbaugh process is worthy of note. This is primarily a scavenging process to remove the zinc from complex lead-zinc ores, giving a more marketable product and leaving the zinc in the form of sulphate as a byproduct. It is essentially a process of sulphate roasting, and in doing this properly lies success; water leaching follows. The first unit is being erected at the Durango plant of the A. S. & R. A Skinner furnace will be used for the roast. The evaporated leach liquors should have an outlet in the lithopone industry.

In blast-furnace practice, the use of pulverized coal in the tuyères should be mentioned. The idea, first tried out at the Tennessee Copper Co.'s plant, was discontinued owing to the presence of coal particles in the exit gas, which was used for acid making. Experiments at the Cerro de Pasco smelter have been so successful that all of the blast furnaces in the new smelter are equipped with powdered-coal firing, and it is likely that the blast furnaces of the Katanga company, in the Belgian Congo, will be similarly equipped. There, an oxidized charge is smelted for black copper, and powdered coal introduced at the tuyères was not only more economical fuel, but established better reducing conditions at the tuyères which markedly cut down the oxidized copper loss in the slag. The same result has been found in lead smelting, experiments at the Midvale smelter, in Utah, being reported entirely successful.

Fuel-oil or powdered-coal firing—dependent entirely on the relative cost—is now used in all the large reverberatory furnaces in this country; and the small refining reverberatories of the Michigan Smelting Co. at Houghton have also successfully adopted powdered coal.

The Utley process for complex lead-zinc ores has been developed experimentally by the River Smelting & Refining Co., at Florence, Colo. It consists of reverberatory smelting to fume the lead and zinc and to produce a matte. The fume is caught in woolen bags in a baghouse and re-treated on "Western type" oxide grates to make a lead-zinc pigment. The Bully Hill plant of the Shasta Copper & Zinc Co. carried on similar work. The process has not been an unqualified success, but results are promising.

A development of interest at the end of 1922 was the patent suit brought by the Peirce-Smith Converter Co. against the United Verde Copper Co., for infringement. The horizontal type of copper converter has been a great success, and in the last few years the development of the Garr gun, for blowing in the flux, has added to its value. The need for the payment of royalty charges on the converter has hindered its application, however.

TECHNICAL DEVELOPMENTS

Mill Design and Construction

Recent Crushing Practice—Dewatering of Concentrate—Lighting—Fine Grinding —Cyanidation—Selection of Millsite

By Ernest Gayford
Vice-President, General Engineering Co., Salt Lake City, Utah

THE MAJORITY OF THE MILLS built during 1922 were designed for the concentration of ores. The trend of mill design and construction has followed the well-beaten path of fine grinding and flotation, with or without gravity concentration. This naturally leads to simplicity of design and economy of space, but to an increased power consumption per ton of ore treated.

In coarse-crushing, the common practice is to reduce the run-of-mine ore in breakers, followed by rolls or disk crushers in closed circuit with vibrating screens, the tendency being to crush finer than heretofore, some plants crushing as fine as ½ to ⅜ in., on the theory that the finer feed materially increases the capacity of the ball or rod mill, and reduces over-all costs.

There is a tendency to extend the use of an individual motor for each machine by inclosed chain drives, Lenix-type drives, or inclosed double-gear reductions. This is undoubtedly a move in the right direction. The additional initial cost is not excessive; it is partly offset by decreased installation cost, and the elimination of belts, giving a clear runway for crawls or cranes. This type of drive also permits the use of motors of high speed, and gives greater over-all power efficiency. The individual motor drive for concentrating tables appears to be an advance over the old countershaft and belt drive, provided the motors are properly protected and the plant is kept reasonably clean.

Improvements have been made in the arrangement of the filter plant for dewatering flotation concentrate, especially in placing the filter above the thickening tanks and providing it with a storage feed tank equipped with a slow-moving stirrer, this tank storing the thickened concentrate from the thickening tank. The filter, being placed above the thickening or storage tanks, can overflow back into them and so maintain a constant level in the filter tank. The storage tank permits the filter to be run only when desired, instead of the entire twenty-four hours. The thickening tank and storage tank should be placed on the same level, the thickened concentrate from the settling tank being delivered into the storage tank by a diaphragm pump, and the product of the storage tank delivered to the filter by an elevator.

More attention is being paid to mill lighting than heretofore, the modern idea turning to series lighting, using large overhead units with low voltage and high amperage, necessitating heavier filaments, and more rugged construction, and insuring a longer life and less temptation to theft. This system of lighting is effective and economical; it prevents accidents and insures better work at night, especially where a two-mineral separation is required. In one 1,000-ton plant, with current costing ¾c. per kilowatt hour, the lighting cost with this type of installation does not exceed 80c. per day. The proper and adequate diffusion of light, both night and day, is of more importance than the average designer appears to realize. Steel is still being used for large mills, and wood construction for smaller mills. In one large plant being built in Canada, the framework of the building will be steel, the walls and roof being covered with gunite. This makes an ideal building, not unduly expensive, and easy to heat.

The rod mill of various types made considerable advance during 1922. As to whether it is a competitor of the ball mill under all conditions, remains to be proved. It is, undoubtedly, by comparison, a low power consumer and an efficient machine, with several other attractive features. The future will probably show that there is a wide field of application for both rod mills and ball mills.

No new development has taken place in cyanide-plant design; all sliming, generally with two-stage grinding, followed by agitation and counter-current treatment, with or without filters, is still practiced. The year's work proves conclusively the benefit derived from deoxidizing the pregnant solution when zinc shavings or zinc dust is used, a considerable reduction being made in zinc consumption and an increase insured in the bullion contents of the precipitate.

The flat millsite versus hillside millsite for medium-sized mills is a subject entitled to serious consideration. The tendency heretofore has been to search for a sloping site for the mill, and sometimes to go a considerable distance away from the mine to obtain it. Although it is admitted that, upon first consideration, the hillside site appears to have advantages, a careful study may show that these are theoretical rather than actual. Even with a hillside site, a number of elevators for returning re-treatment products are necessary; and if by the addition of one or two elevators a level site can be utilized, the bulk of the evidence is in favor of such a site. I recently visited a plant in Idaho, treating 175 tons per day, that was constructed on a level site, and I was impressed with the design. All operating machines are on one level and visible from any part of the mill. The mill crew totals eight men (two men per shift), including two in the crushing plant, who work only one shift. The operating costs are unusually low, and supervision is easy; the operators, having no stairs to climb, can give each machine maximum attention. Several elevators are in use; but these are correctly designed and properly constructed, and have given no trouble since the plant went into operation in January, 1922. With the improvements made in the design and construction of centrifugal pumps, and careful attention to the design of elevators, to be sure that they have plenty of capacity, the level millsite has many attractive features for small and moderate-sized mills.

One of the important developments of 1922 was the starting up of the fine-crushing, wet-magnetic separation and sintering plant on the low-grade iron ores of the Mesabi Range, by the Mesabi Iron Co.

TECHNICAL DEVELOPMENTS

Geology of Prospecting

Ore Deposits and Geology—Granitic Batholiths—Intrusive Contacts—Geology of Porphyry Coppers—Enrichment of Deposits—Recent Technical Literature—Devices to Aid Prospecting

BY WILLIAM H. EMMONS
Professor of Geology, University of Minnesota, Minneapolis, Minn.

THE LAST TWO YEARS have not favored prospecting—a branch of the mineral industry that is the first to feel the pinch of hard times and the influence of low metal prices. Recent progress in the geology of prospecting has been toward a better understanding of ore deposits and their relation to geologic features.

The foremost contributions to the literature of the subject are in connection with the lode deposits that are related to granular rocks. These deposits have been formed at considerable depths and in the middle zones, and nearly all in times as remote as the Early Tertiary. The development of the gold, copper, and silver mining districts in eastern Canada has thrown much light on the genesis of this group of deposits. In that region there are enormous granitic intrusions, and great blocks of earlier rocks are caught up in them or else constitute roof pendants now completely surrounded by granite. The greater number of the ore deposits are in or near these islands of the pre-granite rocks, or elsewhere near the contacts of the granites with older rocks, or in areas of older rocks intruded by granitic or other dikes, probably related to the granites. The Mandy and the Flin Flon mines,[1] in northern Manitoba, are near intruding granite, as are the deposits of Reed and Wekusko lakes.[2] In the Sturgeon Lake region,[3] veins are found in or near intruding granite. The Long Lake zinc mine[4] is in limestone near intruding granite. The gold deposits of Matachewan, northern Ontario,[5] are in altered tuffs and basalt near intruding granite porphyry. Gold ore is found near Lake Megantic[6] in schists and near intruding granite. Many other examples of Canadian deposits near intruded granite have been described recently.

GEOLOGIC CONDITIONS IN AUSTRALASIA

Similar relations in the southern half of Western Australia are even more clearly marked. Granitic rocks cover thousands of square miles. Smaller areas of schists and gneisses constitute islands in the granite, or roof pendants. Hundreds of gold deposits exist in this area, among which the lodes of the Golden Mile, of Kalgoorlie, are best known. Nearly all of the ore deposits of Western Australia are in the islands or roof pendants, a few being in the intruding granite near the contact with intruded rocks. One mile from the contact the granite is almost barren; it covers much more than half of the area that includes the mines, yet it is devoid of deposits.

In Victoria, also, the ore deposits are related to granitic intrusions, but erosion has not extended to such great depths, and the granitic rocks outcrop as large and small intruding stocks. Many of these, doubtless, join at depth. This interpretation, which appears to be a logical one, is given to the structure on the maps of the Geological Survey.[7]

BATHOLITHS AND ORE DEPOSITS

In a critical review of the world's tin deposits, Ferguson and Bateman[8] showed that most of the lodes of tin are near the roofs of batholiths. Lindgren had noted, also, that the gold deposits of California are on the edges of batholiths and associated with minor intrusions near the border of and probably connected below with the great Sierra Nevada batholith. Billingsley and Grimes[9] showed that the deposits of the Boulder batholith and associated smaller intrusives are near the rims, or were once near flat-lying roofs that have been removed by erosion. Butler has shown that the deposits of Utah are related mainly to granitic stocks, rarely to laccoliths. The small stocks, related to larger ones, whose tops have been cut off by erosion are more productive than the larger ones, which have been eroded to planes nearer their bases. Deposits associated with larger stocks are found near their rims, whereas the deposits associated with smaller ones are commonly near the rims and also well within the stock itself. Butler was, I believe, the first to offer an explanation of the barren condition of the interiors of large granite batholiths,[10] which are barren because they have remained molten so long. Differentiation has removed the metals from the magmas and carried them to the tops and sides of the batholiths. From the foregoing and other contributions, it follows that in areas where ore deposits are associated with granitic rocks they should be sought:

1. Well within the borders of small granitic intrusives.
2. At the rims of small granitic intrusives and particularly in the contact areas of small granitic intrusives.
3. Near the rims of larger granitic intrusives.

THE LIMIT FOR GEOLOGICAL GENERALIZATIONS

Valuable deposits in intruded rocks are more likely to be found near intruding rocks, where the contact dips away from the intruding rock. Contacts dipping toward the intrusive suggest a constricted channel and absence of magmas outside the rim.

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[10]Butler, B. S., *Econ. Geol.*, Vol. 10, pp. 101-22, 1915.

TECHNICAL DEVELOPMENTS

Geological generalizations and rules for prospecting are not of much use unless their limitations are known. A few valuable deposits are found within granitic masses of considerable size. The group of lodes of the Ding Dong mine, in the Lands End massive of Cornwall, is a mile from the rim, and the Balswidden mine is 2½ miles away. Both of these were once important mines. The Lands End granite mass is 15 miles long and 5 miles wide. It is, however, a mass of the "flat-roof" type. Professor Davisson, of the Camborne School of Mines, informs me that he has found evidence of this in the numerous fragments of the sedimentary rocks in the granite, evidently broken from the roof.

The foregoing discussion refers to lodes and similar deposits at or near intrusive contacts. In regard to contact-metamorphic deposits—those that replace calcareous rocks near contacts and which appear to be independent of fissures—Umpleby recently made the observation that the sulphide ores are commonly found on the limestone side of the garnet zone.[11] The silicates are evidently deposited most liberally in the early stages of contact metamorphism, and the sulphides most liberally in the later stages. In the Seven Devils region of Idaho, according to Livingston and Laney,[12] the sulphides in the contact-metamorphic zone locally replace the silicates.

Iron ores, like the silicates, are commonly deposited at the early stages of metamorphism. Magnetite deposits are usually found next to the igneous rocks in the garnet aureole. A suggestive paper by Iwasaki[13] describes the iron and gold deposits of Kamaishi, in the northeast of the main island of Japan. The district is the chief iron-ore producing region of the empire. Where diorite porphyrite is in contact with limestone, it is common to find magnetite alongside the porphyrite, garnet next, then quartz and calcite, with gold between the garnet rock and the limestone. These and other observations in contact-metamorphic zones suggest that the outer rims of magnetite orebodies and garnet-magnetite zones offer possibilities in prospecting for gold and copper.

An important recent development in mining is the discovery of large deposits of rich copper ores in limestone near the intruding porphyry at Ely, Nev. The geological histories of the porphyry copper districts of the Southwest have many features in common, but their mining histories differ. Ore was discovered at Bingham in limestone and at an early date; later, the disseminated deposits in porphyry were developed; and, still later, the lead-zinc ores in limestone more remote from the porphyry. The ores in limestone at Bisbee were worked for many years before the disseminated ores in the igneous rock of Sacramento Hill were developed. The disseminated ores at Cananea, in Sonora, were worked before the extensive development of contact-metamorphic ores. Copper ores in each of these centers are found under widely different conditions. In consequence of developments in these districts it will be interesting to watch Chino, Fierro, and other centers of metallization, where disseminated ores or limestone replacements are developed. More than one of these types of ore are developed on a large scale at many places in the camps of the Southwest.

Osmiridium, an alloy of the platinum group, is more valuable than platinum, selling for nearly $200 an ounce. The principal deposits of osmiridium are placers in northwestern Tasmania, in a belt 30 miles long, extending from near Dundas to Heazlewood. Many disconnected outcrops of basic rocks occur in this area, in part altered to serpentine. The placers have been supplied from the decomposition of the serpentine. According to Reid,[14] all of the osmiridium deposits of this area and elsewhere in Tasmania are associated with the serpentine derived from peridotite containing olivine and bronzite, whereas other serpentines derived from less basic rocks, such as pyroxenites and gabbros, are barren.

During the last year, noteworthy contributions have been made to the subject of enrichment of deposits. Lindgren and Bastin have shown that the chief copper deposits of the Braden mine, in Chile, are the results of downward enrichment. The earlier reports on this district gave the impression that the deposits were chiefly primary.[15] The Corocoro district of Bolivia is described by Singewald and Berry.[16] The orebodies are regarded as primary. The amazing feature of the deposits is that the sulphide ores pass into native copper at depths between 120 and 200 meters. Bastin has presented a critical study of enrichment in southwest Colorado. He shows that many of the deposits of the region are secondary, but many, notwithstanding, contain primary ores of profitable grade.[17]

Among several recent papers describing manganiferous gold deposits that have been enriched by descending waters, that of Kuhara is noteworthy. This contribution, which describes the Zuiho mine, Formosa, is in Japanese, a translation having been made by T. Kameda. The deposits show a pronounced enrichment of gold near the surface.[18] A longitudinal projection shows a lean zone near the surface, a rich zone below that, and low-grade material with rhodochrosite at greater depths.

Not much progress has been made in the utilization of electric currents in prospecting since the experiments of Carl Borus on the Comstock lode. Nevertheless, a new apparatus, which makes it possible to detect very slight currents, offers a promising field for inquiry, and work is being carried out along these lines in one or more institutions.

It is well known that the oxidation of iron ores sets up electrical currents[19] in the earth, and it is proposed to utilize slight differences of potential to detect areas of excessive oxidation, and, therefore, certain types of ores. Although progress is being made, there seems to be no evidence that actual performance justifies an optimistic prediction in regard to any of these methods. Nevertheless, it is probable that one or more of them will be used in the future more than in the past, particularly in connection with detailed geologic mapping of structure.

[11]Umpleby, J. B., Univ. of Calif. Pub., Vol. 10, No. 3, pp. 25-37, 1916.
[12]Livingston, D. C., and Laney, F. B., Idaho Bureau of Mines and Geology, Bull. 1, p. 62, 1920.
[13]Iwasaki, C., *Jour.* Coll. Sci. Imp. Univ. Tokio, Vol. 32, Art. 8, p. 9, 1912.
[14]Reid, A. MacIntosh, Bull. Geol. Survey of Tasmania, No. 32, pp. 1-123, 1921.
[15]Lindgren, W., and Bastin, E. S., *Econ. Geol.*, Vol. 17, pp. 75-99, 1922.
[16]Singewald, J. T., and Berry, E. W., Johns Hopkins Univ. Studies in Geology No. 1, pp. 1-115, Baltimore, 1922.
[17]Bastin, E. S., U. S. Geol. Survey, Bull. 735 D, pp. 65-129, 1922.
[18]Kuhara, M., *Jour.* Geol. Soc. Japan, Vol. 25, pp. 333-49, 1918.
[19]Schlumberger, C., "Study of Underground Electrical Prospecting." Translated by S. F. Kelly; Paris, 1920.

REGIONAL SUMMARIES

United States

Summary—California—Nevada—Utah—Idaho—Washington—Oregon—Colorado—New Mexico—South Dakota—Arizona—Montana—Minnesota—Oklahoma-Kansas—Michigan—Eastern States

By Arthur B. Parsons
Assistant Editor

LAWYERS USUALLY start by admitting those things prejudical to their case that the evidence makes it impossible to deny, and then endeavor to convince the court with the preponderance of evidence that tends to prove their contention. Taking a leaf from their book, we concede three things: (1) Only a few mining companies in the United States are producing copper at a profit as the year closes; (2) metal-mine production, generally, is limited by the inability to get competent miners at present wages—if indeed they could be obtained at any reasonable wage; and (3) the excellent position of many silver producers is based on the Pittman Act price of $1 per ounce for the metal. The probability is that custom smelters will stop paying $1 for silver in the early fall of 1923 and the mint necessarily will follow suit a little later. So far as anyone can tell, now, the metal will bring from 30 to 35c. per ounce less after that time. In other words, prosperity in silver mining is held up in large measure by an artificial prop that is about to be kicked away. At any rate an ounce in the mint is worth two (or more) in the mine.

Aside from these three things, the mining industry today is not only flourishing outwardly but is inherently healthy. In spite of the gloomy allegations of one of our western statesmen at Washington, gold mining is more active and prosperous than it has been for five or six years; lead producers, with their metal selling at 7.25c. as against 4.7c. a year ago, and zinc miners, who get 7c. as compared with 4.8c. in January, 1922, are satisfied with the situation—or should be. Iron mining experienced a notable improvement as compared with 1921; and silver producers, with almost feverish activity, are hoisting ore as fast as they can break it. Wisely, no doubt, they are living in the agreeable present without wasting too much thought on what the future has in store.

One consolation for the copper miner is the fact that the surplus stock of refined metal has been reduced during the year from about 750,000,000 lb. to, say, 300,000,000 lb. However, the one-year shutdown, instituted by most of the big producers in April, 1921, resulted in an aggregate output during the first half of 1922 of only about 10 per cent of the productive capacity and since then the rate has not reached more than 60 per cent, though it has increased slowly. To produce economically, most properties must be worked at their maximum capacity. Here enters the problem of obtaining men without further raising of wages—which the companies cannot afford; and, likewise, that of the possible rebuilding of a surplus stock—which they cannot afford either, for fear of a downward reaction in the metal market. However, these matters are discussed elsewhere in this issue, and it will suffice here to say that copper mining is the one branch of the industry that cannot be described as generally prosperous.

The year has marked a distinct advance toward more efficient production and more efficient distribution of the product. War-time operations were grossly wasteful, even if excusably so. The dull period of 1920-21 was devoted to study of the problems of developing more effective and more economical methods of carrying on the industry, and 1922 has seen many of these put into operation, coincidentally with the expansion of zinc and lead mining and the resumption on a limited scale of copper mining. This is not to imply that no further progress was made during the year, nor that the industry is now ready to "lay back on its oars" as far as working toward the avoidance of economic waste is concerned.

Mines have been equipped and operations have been organized so as to decrease the cost of extracting ore and to decrease the number of men required to mine a given tonnage. Although no startling discoveries in ore dressing or metallurgy have been recorded, there has been a tendency toward improving processes so as to get the maximum results at the minimum expenditure. One of the most significant events of the year was the reaching of an agreement by the Jackling interests and the Miami Copper Co., with Minerals Separation, whereby the five big porphyry copper producers, Utah, Nevada Con., Miami, Ray, and Chino, and Butte & Superior became licensees for the M. S. flotation patents. Whatever the merits of the controversy, it was certainly unfortunate that metallurgical and economic efficiency was being sacrificed because of a patent fight.

In many localities some progress was made toward the improvement of industrial relations. The shortage of skilled miners that prevailed during the latter half of the year emphasized the need for a better understanding between employer and employee. Exceptional conditions, both working and social, are inherent in the mining industry. They make the problem peculiar and difficult; but in Arizona and Michigan, among other places, 1922 has seen constructive effort to solve it. A general wage increase of about 50c. per day was made voluntarily by nearly all of the mining companies about Sept. 1.

Probably the most important development looking toward efficient operation and production is the tendency toward consolidation and the formation of bigger organizations. In Utah, two mergers have been effected, with the primary object of cutting down the cost of developing and producing by eliminating duplication. In Arizona, the Phelps Dodge Corporation has acquired

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new properties, principally that of the Arizona Copper Co., Ltd., at Morenci. In December, plans were consummated for the merging of twenty companies in the Lake Superior iron country, whereby iron, coal-mining, shipping, and furnace interests are to be absorbed by the M. A. Hanna Co., one of the largest independent iron-ore producers in the business. In Michigan, eminent engineers are appraising the physical assets of the so-called subsidiaries of the Calumet & Hecla company, for the purpose of establishing a basis for absorption of the smaller companies. It is officially intimated that copper and brass fabricating plants will be acquired by the new corporation to absorb the entire output of the smelters, estimated at 10,000,000 lb. monthly.

The motive for this merger is much the same as that of the Anaconda Copper company in purchasing, in 1922, the control of the American Brass Co., and in concluding negotiations for the acquisition of the Chile Copper Co. These two transactions are the most significant events of the year. The largest producer, smelter, and refiner of copper in the world is merged with the largest single manufacturer of brass, and with the owner of the largest and most cheaply exploited deposit of copper ore. Anaconda owns the largest electrolytic zinc plant in existence, and it is not unreasonable to conjecture that she will expand her zinc-mine holdings so as to produce the second constituent of brass from her own mines. It is impossible to ignore the possibility of forming a huge mine-to-merchant organization similar to U. S. Steel and Standard Oil. There is no question that lost motion can be eliminated, that economies can be effected, and that cheaper manufactures of brass and copper can be supplied to the consumer if a single corporation controls the mining, smelting, refining, alloying, fabricating, and manufacturing processes. Logi-

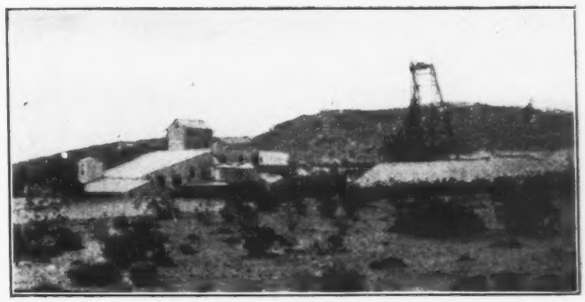
Idaho-Maryland mill

cal progress is in the direction of stabilizing and systematizing and efficiently organizing every phase of the mining industry. The year 1922 has seen great strides toward that end.

CALIFORNIA

The biggest single event in the mining industry of California was the Argonaut mine disaster, in which 47 miners lost their lives as a result of fire in the shaft. According to the findings of a commission appointed by the Governor, the men could in all probability have been saved had prompt and intelligent action been taken by the foreman in charge at the time the fire broke out. The management of the mine appears to be at fault (1) for failure to provide reasonably adequate equipment for fighting a fire, (2) for failure to provide a practicable second exit from the mine, and (3) for failure to train its employees or develop in advance an adequate plan of action to be followed in an emergency. If such a plan had been worked out, the foreman in charge would have known what to do, and immediately would have stopped the fan that sucked deathly gases into the workings where the men were known to be.

The responsibility for the accident should be shared



California Rand Silver company's concentrator

by the officials of the Industrial Accident Commission of California, who are charged with inspecting mines, and who had ample authority to enforce adequate precautions. They lacked either knowledge of what should have been done, or backbone to order it.

Nevertheless gold mining along the Mother Lode is flourishing. At Grass Valley the North Star and Empire produced steadily. One million dollars is said to have been spent in the rehabilitation of the Idaho-Maryland, at Grass Valley, this including the cost of a new mill. Twenty-four gold dredges are in operation.

The California Rand Silver mine, at Randsburg, is the most productive property in the state. It is increasing its mill capacity to 400 tons per day and is shipping 1,000 tons of high-grade ore monthly to the smelter.

Copper production will show an increase, most of the metal coming from the Engels and Walker mines, in Plumas County. The Calaveras Copper Co. is overhauling its smelter, and will resume early in 1923.

NEVADA

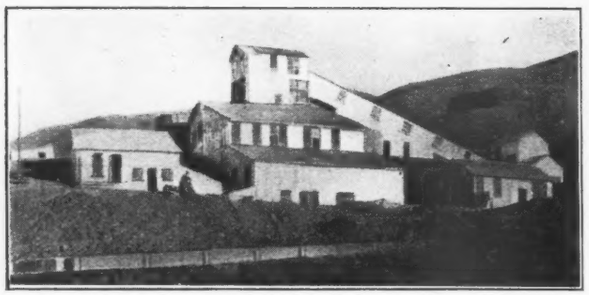
Nevada has been and is enjoying a disease that might be called Pittmanactitis. Undoubtedly there would be many prosperous silver producers without the act, but the approach of the "end" has stimulated silver mining to an extraordinary degree. Time is an important element; the problem is to get the maximum amount of bullion into the mint. Miners at Tonopah in October obtained a 50c. increase to $5.75, after a walk-out that lasted about thirty-six hours. They grasped a psychological opportunity.

Several new milling plants were completed during the year, most of them to treat silver ore. The Candelaria Mines Co. started a 300-ton cyanide plant to treat silver ore in November; the Betty O'Neal company is treating 100 tons of silver ore in its new flotation plant; a plant of similar capacity is being built near by for the Hilltop Nevada Mining Co.; and the 2,500-ton cyanide plant of the United Comstock Mines Co., at Virginia City, was completed to treat the silver-gold ore from a group of old Comstock mines. The ore to be milled is low grade, but large-scale mining operations by eco-

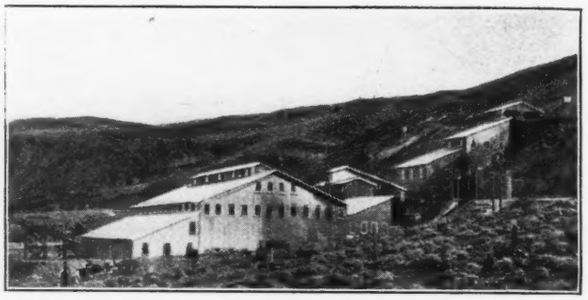
nomical methods, and efficient metallurgical treatment, are expected to make the enterprise a success. Several million dollars has been invested in the project. A 100-ton mill is being built at Cortez for the Consolidated Cortez Silver Mines Co.

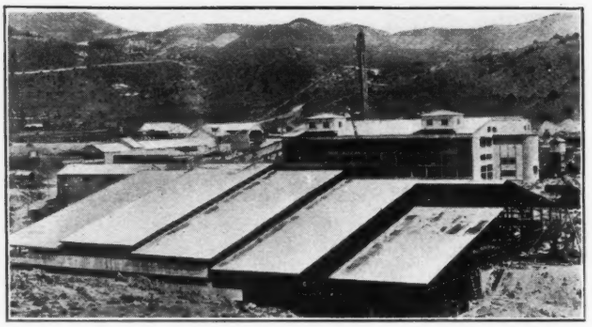
The Simon Silver-Lead Co. finished its 250-ton flotation plant early in 1922, but ran only six months, when production was suspended while a new three-compartment operating shaft was sunk.

Fire on July 9 destroyed the old Nevada Consolidated concentrator at McGill. To the credit of the management, production was resumed within three months of the date of the fire, and now enough units of the new plant are complete to handle 3,000 tons of ore per day.



Simon Silver-Lead (above) and Betty O'Neal (below)





Candelaria (above) and United Comstock (below)

Tonopah is probably the "best" mining camp in the country today, and recent developments at greater depth and at points east and west of the present productive area give operators reason for optimism.

UTAH

The year in Utah has been a good one. The Utah Copper Co. resumed mining at Bingham in April and started the Arthur mill soon after. Later in the year, the Magna plant, the oldest and biggest of all the "porphyry copper" mills, after complete remodeling and the installation of flotation machines, was restarted for the first time since January, 1919. Utah Copper is one of the few companies that can earn an excellent profit on 14c. copper, and it is not unlikely that, as more sections of the Magna plant are finished, the monthly output of the two mills will reach 15,000,000 lb. or more. The new 1,000-ton plant of the Utah Consolidated company at Tooele has been in operation for some months on copper ore from Bingham.

The lead-silver mines at Park City, Tintic, and Bingham operated steadily during 1922. The Silver King Coalition completed its new 500-ton flotation plant at Park City and started it, but the Judge electrolytic zinc plant was idle throughout the year. The Park-Utah enjoyed remarkable prosperity; and, though a comparative infant as mines go, paid $550,000 in dividends during the year.

Two mergers have been effected. In Park City the Park City Mining & Smelting Co. has been organized to absorb the Judge, Daly, and West Ontario companies, the management to lie with the Judge interests. In Eureka, arrangements, without formal consolidation, have been affected whereby the Chief Consolidated interests control and operate the Gemini, Ridge & Valley, and Eureka-Hill mines. In both instances the object is to economize by co-ordinating development and minimizing overhead expense.

A project that means much for Utah and the West is the opening of the vast iron-ore deposits in the southern part of the state. Except for Birmingham, Ala., there is no other place in the country where large deposits of good iron ore are found in comparative proximity to coking coal. A 32-mile branch railroad is being built as the first step toward exploitation.

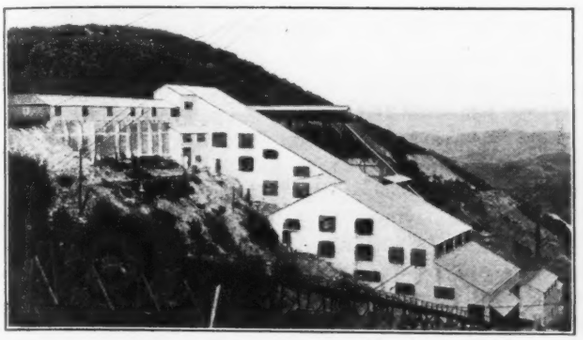
The resumption of operations at the International smelter, at Tooele, and the blowing in of additional furnaces in the other smelters reflect increased output.

IDAHO

The most important event of the year in Idaho was the confirmation by the court, after a long legal fight, of the agreement between the Hecla and Bunker Hill companies to purchase the Star zinc-lead mine, a transaction that was opposed indirectly by the A. S. & R. interests. The significance lies in the fact that the building of an electrolytic zinc plant by the Bunker Hill company at Kellogg is now assured. Mines in the Coeur d'Alene and other near-by districts can produce medium-grade zinc ore that will not stand the cost of a long freight haul.

The Hercules, Tamarack & Custer, Callahan Zinc-Lead, and Success mines resumed operation during 1922; the first three are shipping to the Helena smelter.

REGIONAL SUMMARIES



Silver King Coalition concentrator

The Bunker Hill, probably the greatest lead mine in the world, has found its orebody unimpaired on the new level, 1,600 ft. below the Kellogg adit. The company has completed its new South mill, a fireproof structure covered with gunite. Development work in less important mines is active; 4,000 miners are employed, as compared with 2,500 a year ago.

Producers outside the Coeur d'Alene include the Talache Mines Co., which has completed a flotation plant of 100-ton capacity near Lake Pend Oreille, and the Idaho-Continental at Port Hill, in Boundary County.

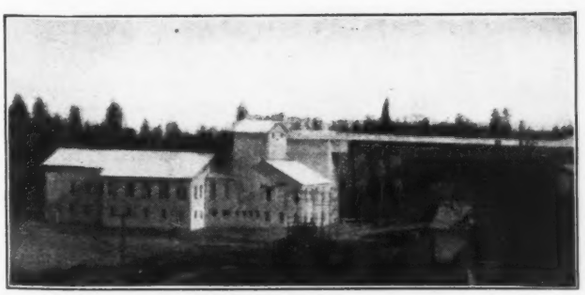
Washington and Oregon

The crystallization of the plans of the Bunker Hill company to build a zinc-treatment plant in Idaho has helped to stimulate activity in Washington and Oregon, and interest is generally greater in mine development. The Bead Lake Gold & Copper Mining Co. has a new 100-ton concentrator at Newport. A number of mines, including the Gladstone and Electric Point, are producing near Northport, as are several in the Republic gold district. The smelter at Tacoma operated continuously, principally on ores and concentrate from Alaska and British Columbia. The Northport smelter was dismantled after purchase by the A. S. & R. Co.

Operating mines in Oregon include the Cornucopia, where a new adit is being driven, the Iron Dyke, near Homestead, and the Bay Horse, a new but substantial producer.

Colorado

Mining in Colorado looks much better than it has for a long time. This is due partly to the fact that it has looked pretty bad in recent years, and partly to some real constructive work done in the last year. The Metals Exploration Co., the A. S. & R. Co., and, we understand, some of the railroad companies, have put



Talache 200-ton concentrator

their heads together in an effort to restore the industry to health. The two first companies have financed the Complex Ores Recoveries Co.; and a 50-ton unit, costing $250,000 and using the Coolbaugh process, will be completed at the Durango plant of the A. S. & R. Co. early in 1923. Complex ores have long been the stumbling

1,000-ton Utah Con. flotation plant

block of many mining companies in Colorado, and if the new process is as successful as its backers think it will be, the industry will be stimulated immensely. The same interests are building a 300-ton concentrator and a 7½-mile bucket-rope tram to handle ore from the old Rawley property, in Saguache County.

Other well-managed outside companies that have come into the state are the East Butte Copper Co. and the Tonopah Mining Co. The former finished a 400-ton mill at Silver Plume to treat silver ore from the Dives-Pelican and Seven Thirty groups. The Tonopah Mining Co., through its subsidiary the Tonopah-Ajax Co., has taken over the Ajax property, at Cripple Creek.

Important discoveries of ore were made in 1922 in the Portland mine, at Cripple Creek, and in the May Day mine, in La Plata County. A 5,000-yd. dredge,

Bunker Hill "New South" mill

costing $400,000, started operation near Fairplay, in Park County, in June.

The prosperity of Colorado's mining industry will not be reflected in the statistics of output for 1922, but it should show in the record for 1923.

Arizona

Arizona is essentially a copper-mining state, and copper production had been almost entirely suspended in January, 1921. The casual visitor would have con-

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Copper Queen concentrator

cluded, with reason, that the industry was virtually dead. That it was merely in a state of coma became apparent early in the year, when the larger mines at Globe, Miami, Bisbee, Jerome, Ray, and Morenci, in the order given, resumed production on a scale much below capacity. There has been a gradual increase in the rate of output, though few are up to their economic maximum, and the production in the aggregate is about 60 per cent of normal capacity.

Generally speaking, the Arizona companies made excellent use of the enforced idleness—the "idleness" of course referring only to production. The Phelps Dodge Corporation instituted a real system of employees' representation in the conduct of company affairs that has so far proved beneficial. All of the companies spent money and effort in systematizing mine-safety work and in improving conditions underground and in the communities where the families of employees must reside. They have felt the shortage of miners less than in some other sections of the country. The 4,000-ton Copper Queen concentrator at Bisbee has been completed and is ready to operate. The United Verde, in the Jerome district, has completed an elaborate program of plant improvement; Inspiration has sunk a large new working shaft; New Cornelia is proceeding with the construction of a flotation plant and the Magma Copper Co. has constructed an 18-mile standard-gage railway as a preliminary to the immediate construction of a smelter at Superior. The Old Dominion, Morenci (Phelps Dodge), and Magma flotation plants have been remodeled to give greater capacity and more efficient metallurgical results.

It is safe to say that practically all of the companies are in position to make copper much more economically today than they ever did before—providing of course that they work at normal capacity. As in the other copper states, producers are optimistic for the coming year.

To Oatman, for the moment, we concede the palm for being the most active candidate for the laurels of Goldfield. Doubtless there are plenty of wildcats, but the United Eastern is working steadily and the U. S. Smelting company is about to reopen its once profitable Gold Road property.

MONTANA

It is hard to tell what the Anaconda company would do if it could get all the miners it wanted at present wages. The scale is $4.75, but 80 per cent of the underground men are averaging $6.25 on contract. Anaconda might not see fit to increase production to the maximum capacity, but it is estimated that 3,000 miners could find employment at Butte. Butte feels the labor shortage worse than any other district. The companies there do not hesitate to spend money to ventilate the mines and to make them safe, but there seems always to be a lack of understanding between employer and employee. When there are lots of idle men, the companies have the whip hand; and, figuratively, they use the whip. When jobs are plentiful and it is easy to get work, the positions are reversed, and the miners retaliate by doing the minimum day's work.

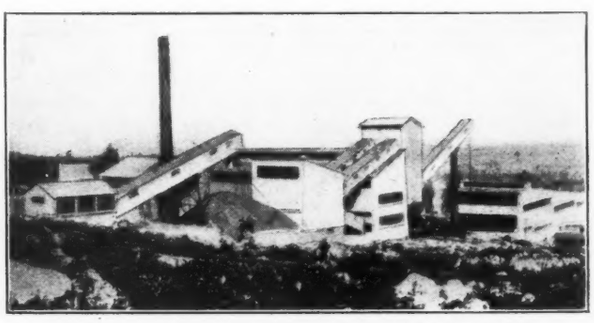
However, Butte is a busy place today, with about twenty mines in operation (counting Anaconda's separately), and 10,000 tons of copper and zinc ore is being hoisted daily. As in Arizona, production was almost nothing on Jan. 1, 1922; but the Butte & Superior resumed mining zinc ores during that month and all of the other companies followed before the mid-year. Butte & Superior, freed of the incubus of the Minerals Separation suit, paid a dividend in November, the first in five years. The Butte & Superior and Senator Clark's Elm Orlu, as well as the Emma mine, are supplying Anaconda's zinc plant at Great Falls with all the concentrate it can handle—enough to make about 10,000,000 lb. of zinc per month.

1,800-ton Homestake mill

The stellar fiasco of the year in the United States was probably the completion of a 500-ton mill by the Boston & Montana Co., at Wise River. This appears to be a case of much mill and little mine. The American Zinc, Lead & Smelting Co. is erecting a 400-ton flotation plant at the Silver Plume property which it acquired recently.

NEW MEXICO

The only important mine in New Mexico not working is the Burro Mountain, of the Phelps Dodge Corporation, at Tyrone. The company considers it more economical to draw what ore is needed from its Arizona



Mesabi magnetic concentrator at Babbitt

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and Mexican mines. The Chino Copper Co., at Santa Rita, resumed April 1, with the other "porphyries." Output is still restricted to a basis on which there is little or no profit. The Calumet & Arizona is shipping about 300 tons of siliceous copper ore daily from the "85" mine, at Lordsburg, to the smelter at Douglas. The Mogollon Mines Co. is working 100 men and maintains a regular output of gold-silver ore.

South Dakota

The condition of the gold-mining industry in South Dakota during 1922 may be described in one sentence: "The Homestake company doubled its rate of dividend." The Homestake ore doesn't change much, and profits depend upon the cost of supplies and labor and the economies in mining and milling. The New South mill is now doing the crushing, and operation of the old plant is discontinued. The Trojan was active all year.

Minnesota—the Iron Ranges

Perhaps the most significant event of the year in the iron-mining ranges of Minnesota and Michigan was the starting of the Mesabi Iron Co.'s magnetic separation plant for concentrating the low-grade magnetite ores of the eastern Mesabi. Large-scale operations with economical mining and efficient fine grinding are depended upon to win a profit from material that has hitherto been considered worthless. Progress has been made in reducing underground mining costs. The development of scrapers, run by air hoists, for loading in stopes is important. The Oliver Iron Mining Co. has started a $1,000,000 shaft at the Geneva mine, on the Gogebic Range. This shaft will be 4,000 ft. deep; the greatest depth attempted heretofore in the iron mines has been 2,600 ft. This departure is significant.

Oklahoma-Kansas

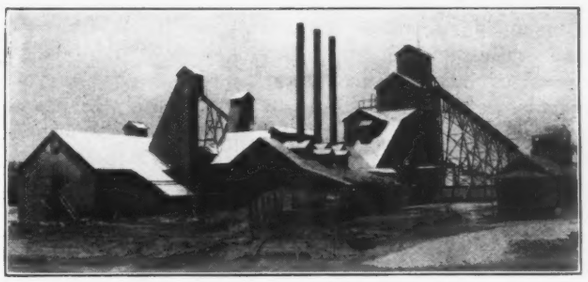
In January, 1922, 40 mills in the Picher and Baxter Springs districts were producing 4,000 tons of zinc and lead concentrate per week; today 130 mills are producing nearly 12,000 tons. At the beginning of 1922, zinc "ore" brought $28 per ton. Now it brings $45, and lead had advanced from $58 to $93. No work of any consequence was done in the Joplin and Webb City districts. This tells the story of mining in the tri-state region. Down there a "run of ore" is a run of ore, and a "mill" is a mill, and "jack" is jack. If the prices for jack are good, the operators throw up a few more mills, lease a few new tracts, and start drilling the "land" to determine the position of a few more runs of ore so as to keep ahead of mining operations. If prices drop, the less profitable mills are shut down, output declines, and many of the miners go back to farming. It is delightfully simple.

The Barnsdall Zinc Co. built two new mills and was the largest producer in 1922; the Eagle-Picher company is running seven mines; the Commerce Mining & Royalty Co., eight; the Chanute Spelter Co., three; the St. Louis Smelting & Refining Co. has started two mills and is erecting two more; the Kanok Metal Co. is operating two mills at Picher, and will soon be operating two more near Crestline.

Michigan—the Copper Country

The problem in Michigan as in other copper-mining districts is: How to produce copper at *any* profit—and then how to increase that profit. The fact that conditions in Michigan make the solution of the first part of the problem particularly stiff accounts perhaps for the effort that is being applied to it.

Measures for economy may be enumerated as follows: Keener selection of "rock," so as to give a higher yield per ton; more extensive use of electrical pumps and of mechanical loaders and scrapers in levels and stopes; concentration of haulage: for example, the completion by Calumet & Hecla of the 81st level haulageway will effect a saving in hoisting cost; centralization of power plants and shop work; regrinding of rock in the stamp mills to reduce copper losses, especially in



No. 3 mill, Chanute Spelter Co.

amygdaloid rock; installation of automatic handling equipment in the smelters; use of pulverized coal (in the Michigan smelter), which has cut the fuel bill for firing furnaces 33⅓ per cent; and the introduction of a contract system of payment for underground men, whereby the men get more than day's pay and the company gets lower unit production costs.

Eastern States

In Tennessee, the American Zinc, Lead & Smelting Co. operated the Mascot mines steadily but on a curtailed basis during the first half and at capacity since

McBee mill, Kanok Metal Co.

the mid-year, in 1922. The Tennessee Copper Co. has started a new flotation plant at Copperhill. The New Jersey Zinc Co. experienced difficulty throughout the year in obtaining miners at Franklin and neighboring towns, in New Jersey, and output is restricted. Even a $5 wage fails to attract men for underground work.

Alaska

The gold output decreased and the copper output increased in Alaska in 1922. An unusual number of new dredges are almost ready for operation, and an increase in the production of placer gold is anticipated. The Alaska Juneau company appears to have solved the difficult problem of treating profitably the low-grade lode ore. The Kennecott group of mines contributed nearly all of the copper produced—68,000,000 lb.

REGIONAL SUMMARIES

Canada

Feature of 1922 Is Strength of Gold Industry—Expansion at Porcupine —Coal Mining—Silver—Copper—Lead—Zinc

By R. E. Hore
Consulting Geologist, 404 C. P. R. Building, Toronto, Canada

THE LAST TWO YEARS have been a trying period for the mining industries of Canada, and output has been below normal. A marked increase in the production of gold is noticeable, but this is insufficient to offset the diminution in receipts from other minerals. During 1922, however, there was a revival of interest in exploration and a slow improvement in market conditions. In Ontario the poor market for nickel and copper depressed the Sudbury nickel district. After a long period of non-production, the International Nickel Co. recently resumed operations on a small scale. The British American Corporation's smelter is still idle. The Mond Nickel Co. did not close down, but reduced output. Low prices for silver have resulted in a lessening in activity at Cobalt, but notable success has accompanied the development of silver properties in the South Lorraine township, to the southeast.

The improved conditions for gold mining and the excellent results being obtained by producing companies have led to the development of new gold properties. The production of gold has substantially increased, and a still larger output is expected in 1923. Remarkable success has been achieved by the Premier Gold Mining Co., in the Salmon River district in British Columbia, where a rich deposit of gold-silver ore is being mined. The Consolidated Mining & Smelting Co. has had a good year, there being a fair market for the product of its big zinc mine. The Britannia Mining & Smelting Co. has completed a considerable amount of construction work; its new mill will have a capacity of 2,500 tons per day. The Granby company has been producing steadily at Anyox, although the market for copper has been unsatisfactory.

Iron mining in Newfoundland seems likely to assume bigger proportions during 1923, owing to a demand for iron ore in Germany. The deposits are extensive; they supply the ore used in the Nova Scotia iron and steel industry, and could also supply a large amount for Europe. In Ontario an endeavor has been made to find out what can be done with the idle iron-ore deposits there. The provincial government has appointed a commission to report on the possibility of establishing an iron-mining industry. The adaptability of concentration processes is a feature that will be studied.

The most important mineral in Quebec is asbestos, the eastern townships of the province yielding most of the world's supply. During the last two years the market has not been good, and production is below normal. In northern Quebec, near the Ontario border, a long-delayed exploration has begun for gold deposits. Prospecting carried on in 1922 is expected to result in vigorous exploration in 1923. Conditions are reported to be favorable, and there is hope of finding deposits that will stand comparison with those now under development on the Ontario side of the boundary.

The success of Canadian gold-mining enterprises has been a feature of 1922. The mines at Porcupine and Kirkland Lake, in Ontario, have increased production, and have proved by continuous development to be of greater importance than was supposed. The experience gained in Ontario is building up a strong foundation for confidence that the province has unusual possibilities as a gold producer. Development was carried on in several districts during 1922, and the results obtained are in line with the experience of the producers.

Important work has been done on undeveloped properties at Porcupine, close to the producing mines. Other properties, partly developed some years ago, are being explored further. New mines at a considerable distance from the center of activity are being opened up, and the Porcupine gold area is widening again. The Night Hawk Lake district is being proved satisfactorily, and it is reasonable to expect that 1923 will see an increased activity in the exploration of properties in many parts of the Porcupine area. Hollinger, McIntyre, and Dome are all improved by work done during 1922, and all should show an increased production in 1923. The Porcupine V. N. T. has been reopened. The Newray is being explored by diamond drill. Goldale and Rochester are getting good results. Some rich ore has been found at the Paymaster. The Clifton has installed a small mill. The Dome Lake is being operated again by a newly organized company. The long-delayed intensive exploration of the area has only just begun, and, if it receives the attention it deserves, work should be in progress in 1923 at a large number of properties.

At Kirkland Lake the last year's work has greatly increased confidence in the possibilities of developing good orebodies along the main ore zone or fracture. Notable success has been attained at the Teck-Hughes, where excellent ore has been developed after several years of unprofitable operation. At the eastern end of the developed part of the "fracture," the Tough Oakes has met success in finding ore, after a period in which none was in sight. The middle part of the producing zone, operated by the Lake Shore and Wright-Hargreaves companies, has continued to produce profitably. The western part, operated by the Kirkland Lake and Teck-Hughes companies, was a disappointment for some time, but opinions changed materially as the work advanced at the Teck-Hughes mine. It is reasonable to expect that Kirkland Lake will find ore, following the experience of its neighbors. The results obtained in the ore zone are giving confidence to those who believe in the possibilities farther along its strike; and exploration on a large scale was started in 1922 by the Continental Mines company, which has acquired a number of claims east of those of the present producers. At the Bidgood, farther east, development is in progress. The Montreal Ontario has been reopened after a shutdown of several months.

In the Shiningtree area, development work is being carried on by the Ribble Mines company, which is oper-

ating the Wasapika property, and by the Tonopah Mining Co., which is developing the Herrick mine. The Ribble vein is being opened up at the 100- and 200-ft. levels. The shaft at the Herrick mine has been deepened to 300 ft., and exploration is progressing at that level. Some work is being done at the Westree mine. Development was carried on at the White Rock mine in the early part of 1922. Diamond drilling is in progress at the Kingston mine, and it is said that a shaft is to be sunk on the Buckingham property.

At Lardner Lake, the Crown Reserve and Canadian Associated Goldfields companies are getting good results on the development of veins that cross the boundary between the properties of the two companies. A few miles to the northeast, the Argonaut Gold company is developing at the 500-ft. level. Farther north, near Lake Abitibi, some successful exploration work has been done in the Lightning River area. The Abitibi Gold Mines company has begun shaft-sinking operations.

In western Ontario, north of Sault Ste. Marie, the Goldreau Gold Mines company is developing a promising property. Two shafts have been sunk in the vein, and drifting is in progress. Farther west, near Kenora, work has been started again on gold properties that have long been idle.

Operations at Premier Mine Highly Satisfactory

The most notable new gold mine in Canada is in British Columbia—the Premier—where a wonderful ore deposit has been developed. During 1921 the company shipped 18,750 tons of ore, containing 40,104 oz. of gold and 1,177,978 oz. of silver. Recent monthly production is reported to be 3,000 tons of ore averaging $80 per ton, and 3,000 tons averaging $30 per ton, in addition to about 3,000 tons treated at the mill. The company paid $400,000 in dividends on Dec. 31, 1921, and since then has paid one dividend of $500,000 and three dividends of $750,000 each. The Premier is today the most profitable mine in British Columbia, although two years ago it was scarcely known.

The production of gold in Ontario in 1921, according to the Department of Mines, was $14,702,268. It is expected that the output for 1922 will be at least $20,000,000 and that in 1923 a similar increase will be recorded.

Silver production has fallen off greatly in Ontario during the last few years, but the value of the output was fairly well maintained until 1921, because of the high prices that prevailed from 1917 to 1920. The decrease in quantity in 1921 as compared with 1920 was 2,567,000 oz., but the decrease in value was $5,240,957. With the lower prices now obtainable, only a few companies are operating profitably, but discoveries are constantly being made that encourage new exploration for high-grade deposits. Notable results have been obtained this year at the Keeley and Haileybury Frontier properties, in South Lorrain Township. At Cobalt, the Nipissing, O'Brien, Mining Corporation, and Coniagas companies are the chief producers. The Mining Corporation has become interested in South Lorrain properties, and is meeting with success there. At Gowganda, the O'Brien and Castle-Trethewey mines continue to produce. Recently, the Coniagas company made arrangements for the development of the Beaver and neighboring properties. The O'Brien mill, at Cobalt, was destroyed by fire in the summer of 1922, but the company purchased the Bailey mill, and was not long without facilities for ore treatment. Some of the Cobalt companies are now developing gold mines. Crown Reserve is getting good results in the Lardner Lake area, and Kerr Lake, at the Goldale property, at Porcupine. Coniagas is exploring, by diamond drill, the Newray property, at Porcupine.

Next to Ontario, the chief silver-producing province in Canada is British Columbia, a considerable proportion of the metal being recovered from silver-lead ore. The Premier gold-silver mine, however, is maintaining a large output of silver, which helps to offset the decrease from the silver-lead mines of the Slocan district.

Copper Mining in Canada Is Marking Time

British Columbia, Ontario, and Quebec are the chief copper-producing provinces in Canada. The chief producing company this year is the Granby Consolidated, in British Columbia. The mines and smelter at Anyox operated steadily during 1922, the company mining a considerable amount of copper from copper-gold ores. The big copper mine of the Britannia company has produced little ore during the last two years; the mill was destroyed by fire early in 1921 and the town of Britannia Beach was almost wiped out by a flood. The company, however, has been busily preparing for a resumption of operations, and now has a mill of 2,500 tons' capacity.

Copper is produced in Ontario from the ores of the Sudbury district, that metal and nickel being the chief constituents of the ores mined by the nickel companies. The weakness of the market for nickel and copper resulted in a low output of both metals during 1922, but it is expected that 1923 will show an increase in production. Copper ores have been mined for many years in Quebec, the product being treated to recover sulphur. Poor markets for copper and sulphuric acid have made operations unprofitable, and production will be small until there is an improvement in conditions.

British Columbia Contributes Lead and Zinc

During the last two years a large production of lead and zinc has been made by one mine in British Columbia, and only a little from other properties. The Sullivan mine of the Consolidated company is credited with keeping up British Columbia's lead and zinc output to approximately normal figures at a time when many lead-zinc mines have been idle. The lead-zinc ores from the Sullivan mine are being treated at Trail, the zinc being recovered electrolytically.

The year just ended has not been a notable one in the Canadian mining industries, but a marked improvement has been in evidence of late in several centers. In others, a weak market still restricts production, but it has not prevented preparations being made for increased output in the future. The unusually long period of low prices has been a severe trial for many mining enterprises, and operating losses have occurred that have dissipated a large proportion of war-time profits. However, a better feeling now prevails than at this time last year. The good results being obtained by the gold-mining companies are particularly noteworthy, and these are responsible for much of the activity in exploration in Canada.

REGIONAL SUMMARIES

Mexico

By Henry M. Payne
Consulting Mining Engineer, New York

MINING CONDITIONS in Mexico improved notably during 1922, although development was erratic and for some months many of the smelters were shut down or working only at part capacity. The year 1912 showed the highest silver output on record, but the production for the first nine months of 1922 has fallen only 4.79 per cent behind that of the same period ten years ago. Many of the older mines have remained inactive, so much of the production has come from new operations.

The Coahuila coal fields operated for several months at only about one-half capacity, due to the increase in the use of fuel oil by the railroads and the low price of lead, which caused many of the smelters to suspend, with a corresponding diminution in the consumption of coke. Copper smelters have shown increased production since July; and the slight improvement in the price of lead has helped the silver-lead producers.

The increase in the output of gold has not kept pace with the increased output of silver, due to the fact that most of the properties producing silver and gold are showing more silver and less gold at depth. The Real del Monte mill is operating at full capacity. The Santa Gertrudis company, at Pachuca, also operating, is opening new workings on the Malinchi property at its Santa Tomas shaft. The third important property in the Pachuca mining district is the San Rafael, which is in regular operation. One of the most interesting developments of the year has occurred at the Fresnillo unit of the Mexican Corporation, at Fresnillo, Zacatecas. The capacity of the mill has been increased from 3,000 to 3,500 tons, and the property will be operated as are the big low-grade copper properties in Utah. Silver content is said to average 200 grams per ton, and operating cost not to exceed 35c. gold. Three million tons of ore is blocked out.

Production of Gold and Silver in Mexico, First Nine Months of 1921 and 1922

In Troy Ounces

	Gold		Silver	
	1922	1921	1922	1921
January	50,530	55,971	5,021,623	5,753,114
February	46,939	47,388	4,978,322	4,648,829
March	55,282	42,451	5,526,734	3,132,835
April	42,636	37,145	4,633,543	3,979,906
May	49,236	44,959	5,740,525	3,205,462
June	49,690	41,712	5,556,625	4,167,610
July	46,200	43,296	4,970,381	4,276,510
August	58,291	50,767	5,814,890	4,291,003
September	52,747	45,672	5,025,478	4,318,961
Totals	451,551	409,361	47,268,121	37,774,230

The American Smelting & Refining Co.'s new Angangeo mill, in Michoacan, was put in operation in September, 1922. An English corporation, with a branch in the United States, has been examining silver properties in Saltillo, Durango, Chihuahua, and Zacatecas, with a view to large-scale operations.

In the Guanajuato district, the Guanajuato Consolidated, the Guanajuato Reduction & Mines Co., and the El Cubo Mining & Milling Co. are running full time; development is progressing at the Pasadena el Monte mine. Resumption of work on the Sud Pacifico de Mexico, in Nayarit, and the proposed extension of the Nacional lines from San Marcos to Ixtlan del Rio have induced great activity in western Jalisco and Nayarit. The Humboldt Mining Co. has begun operations at Montjaras Mountain, six miles south of Ixtlan del Rio, and has shipped engines, compressors, and other equipment by steamer to Manzanillo.

The failure of private banks in Mexico during the latter part of 1922 accentuated the value of the metallic currency now in use, and served to concentrate financial transactions into old-established lines. In general, crops were good during the year, transportation conditions were improved, labor was abundant, and unemployment decreased. The outlook for 1923 is reassuring.

Cuba

By C. M. Weld
Weld & Liddell, Consulting Engineers, 2 Rector St., New York

MINING ACTIVITIES in Cuba during 1922 continued at a low ebb, due to local financial distress and to general world conditions. The Bethlehem Cuban Iron Mines Co. produced nearly 463,000 tons from its Jurugua and Daiquiri mines, of which approximately 415,000 tons was shipped; a railroad was built from Jurugua to Daiquiri, so that ore from both mines is now dispatched from the latter port. The North Coast soft-ore iron mines at Mayari remained idle.

Activity in manganese was confined to the Bueycito mines of the Sun Development Co. in Oriente province. A small concentrating plant was erected, and the mines were connected with Julia, on the Manzanillo branch of the Cuba Co. R.R., by 22 kilometers of narrow-gage railroad. Production in 1922 is said to have amounted to about 3,000 tons of dioxide ore.

The Matahambre copper mine, in Pinar del Rio, was operated by the American Metals Co. Its production for 1922 was about 24,800,000 lb. of fine copper and perhaps 90,000 oz. of silver, representing roughly 60,000 tons of hand-sorted ore, plus concentrate averaging a little more than 20 per cent copper and 1.5 oz. silver per ton. From a quarter to a third of the shipments comprised hand-sorted material, the remainder being concentrates. It is reported that a rope tramway from the mine to the shipping port is to be constructed. The El Cobre mine remained idle, and no new copper development of importance is reported elsewhere. No work was done at the Carlota pyrites mine, in Santa Clara province.

Extensive explorations in the Isle of Pines are said to have developed about 3,000,000 tons of gold-silver ore valued at about $5 per ton, and containing about 5 per cent of arsenic and 5 per cent of antimony. The vein is reported as outcropping for over 8,000 ft., with an average width of 45 ft. Plans for equipping the property are temporarily suspended. This enterprise is in private hands, no funds or credit being sought from the public. Developments in the Holguin gold district are reported to be in progress.

The shallow wells at Bacuranao (20 km. east from Havana) continued during 1922 to produce a few barrels of oil daily, and a small production of naphtha came from the Motembo farm, in Santa Clara province. Drilling has continued in one deep well near Taco-Taco, in Pinar del Rio, but so far without results.

I have gathered the above information from a number of sources, and desire to acknowledge my indebtedness to all those who have contributed their help, particularly to J. C. Porter, of Havana, and William Pitt, of Santiago, Cuba.

REGIONAL SUMMARIES

South America

General Review—Colombia—Ecuador—Peru—Chile—Bolivia—Argentina—Brazil—Guianas and Venezuela

By G. W. Tower, Jr.
Guggenheim Bros., 120 Broadway, New York

MINING IN SOUTH AMERICA in 1922 showed an improvement in the value of output over 1921, principally in copper and tin, roughly estimated at $25,000,000, due to the completion of the enlarged and new plants of the Braden, Chile Copper, and Cerro de Pasco companies, so far as copper is concerned; to the resumption of operations in the smaller tin mines in Bolivia; and to improved prices for tin and copper. The production of some of the "war" metals and minerals has ceased, including chromite in Brazil, manganese in Chile, and molybdenum in Peru. A reduction of about 85 per cent in the output of tungsten is noticeable in Peru, Bolivia, and Argentina.

No radical change in mineral production in the immediate future seems likely, except in regard to copper; present indications are that, assuming normal conditions, an additional production of about 100,000,000 lb. a year will be maintained. Considerable activity occurred in 1922 in the search for new properties, but no reports of a find of importance during the year have come to my attention. A large number of properties now idle have been worked to the extent of their rich and easily treatable ore. These constitute a valuable asset, particularly in Peru, but one that cannot be capitalized until railroads or automobile highways have been built.

Approximate Estimate of Metal and Mineral Production in South America in 1922

Platinum	$2,400,000	Antimony	$2,000
Gold	11,000,000	Manganese	4,000,000
Silver	10,000,000	Precious stones	2,000,000
Copper	45,000,000	Tungsten	150,000
Tin	18,000,000	Mica	300,000
Lead	210,000	Bauxite	65,000
Zinc	50,000	Vanadium	200,000
Bismuth	750,000	Zircon	3,000

Colombia

The South American Gold & Platinum Co., operating in the *intendencia* of Choco, installed, during the year, a third steel dredge of a capacity of 125,000 cu.yd. per month. The Oroville Dredging Co. is operating the Nechi and Pato placers with apparently the same success as for the last two years. Development of the Constancia mine has been started. It is reported that a 300-ton mill will be built on the property in 1923.

Ecuador and Peru

The South America Development Co. is the only operating company in Ecuador. Production averages 3,000 to 4,000 oz. of gold and 60,000 to 70,000 oz. of silver per annum. The mining of manganese ore has ceased.

Events of importance in Peru in 1922 include the closing of the Backus & Johnston smelter in November, and the blowing in of the new smelter of the Cerro de Pasco Co., at Oroya, in the same month. This has a capacity of 2,500 tons, and cost $9,000,000. The American Smelting & Refining Co. is operating in northern Peru as the Northern Peru Mining & Smelting Co. The company is developing, under option, the Quirivilca copper property, and has acquired an interest in a silver-gold property, the Diana mines, and others in the Milluachaqui district. A 12-kilometer rope tramway is being constructed, together with a small mill and hydro-electric plant.

The production of vanadium, tungsten, molybdenum, and bismuth in Peru is negligible, or has ceased entirely, with little prospect of the resumption of operations, except in regard to vanadium.

Chile

The year 1922 marked the highest point in production and efficiency at the mines of the Chile Copper Co. From a production of 27,000 tons of copper in 1921, the output was raised to 67,000 tons in 1922. A production of 110,000 to 113,000 tons is possible in 1923. The grade of ore treated in 1922 was 1.71 per cent copper, compared with 1.70 per cent in 1921. Production costs have been reduced from 10.8c. per pound in 1921, to 6c. per pound at the present capacity. These results have been accomplished by augmenting the power plants and other equipment, by perfecting blasting and shovel operations, and by the introduction of a new insoluble anode for use in the electrolytic cells. These improvements, with reduced general and indirect expenses, have brought the costs, if allowance be made for world-wide increase in factors entering into costs of production, far below the original estimates. The efficiency of the labor force added during 1922 is improving, and this should be reflected in a further reduction of costs for 1923.

A great deal of experimental mining was done during the year at Chuquicamata, the results of which forecast cheaper operating costs for the future. Two types of electric shovels are used. The assignment of each type to the class of work for which it is best fitted has increased shovel efficiency greatly.

The year 1922 will be a memorable one for the Braden company because of the sudden expansion of operations from a period of enforced curtailment to a point of maximum production, by utilizing the new extension of the plant. A new smelter was built about four miles from the mill, connection being made by a rope tramway, to supplement the steam railroad. The rate of increase in output is shown by the following figures of tonnage milled per month in 1922, as compared with an average of 61,000 tons per month in 1921: January, 106,940; February, 123,246; March, 181,284; April, 194,446; May, 255,279; June, 258,450; July, 286,087; August, 184,345; September, 216,549; October, 342,720; November, 279,381; December, 336,443; total for 1922, 2,866,170 tons.

In October, 1922, the full nominal capacity of the extended plant was reached, the ore milled coming almost entirely from the Teniente mine. Mill heads averaged 2.30 per cent copper, with 0.06 per cent in

the form of oxides. The production from the smelter for the year was 46,938 tons of copper. The output rose from 1,000 to over 6,000 tons per month during 1922.

The new smelter at Caletones was put into operation on Feb. 19, 1922. It started with a minimum of trouble and has since been working continuously and with satisfactory results. Shipments of iron ore from Tafo, by the Bethlehem Steel Co., continued throughout the year at the rate of 30,000 tons monthly. It is expected that the output for 1923 will exceed that of 1922.

It is reported that a French company has undertaken the equipment and operation of the manganese mines at Marquesa, and that an output of 300,000 tons per annum will begin some time in 1923. The ore is reported to average 50 per cent manganese and 8.5 per cent SiO_2. It can be laid down at Chilean ports for $3.50 to $4 per ton, so the report states. The Neuva Elqui copper mines, near Coquimbo, are being equipped for operation, an automobile road, 85 kilometers long, having been built in 1922. The Du Pont company is constructing an explosives plant at Calama, near Chuquicamata, which will be finished in 1923.

Sulphur mining in Chile is expanding. Annual production is estimated at 20,000 tons, with costs at tidewater given as $23.12 per ton. At such a price the product can be used only for local consumption.

Bolivia

The National Lead Co., Simon Patiño, and English interests are reported each to own a one-third interest in the Williams Harvey tin smelting undertaking. The concentrate produced from the Llallagua mine, estimated to amount to 9,600 tons per annum, will be smelted at the Williams Harvey plant at Brooklyn, N. Y. The Aramayo mines produced 2,550 tons of concentrate in 1922.

The development program was continued at the Caracoles mines of Guggenheim Bros. during 1922. This year, a mill with an annual capacity of 60,000 to 75,000 tons will be built, together with the necessary additions to the existing hydro-electric power plants at Calatranca and Pongo. Henceforth the operations will be conducted by the newly organized Caracoles Tin Co., of Bolivia.

It is expected that, by the end of 1923, the Trans-Andean railway, connecting La Paz and Buenos Aires, will be completed. This will enable several mines, notably the Oploca, to expand operations. It is to be noted that Mr. Patiño has acquired the Colquechaca mine.

Argentina, Brazil, The Guianas

Mica is apparently the only mineral in Argentina in which there was any activity in 1922, the muscovite produced being valued at about $50,000 per annum. Gold, manganese, diamonds, mica, and monazite were the principal metals and minerals produced in Brazil. Manganese production was about 40 per cent higher in 1922 than in 1921, being 186,000 tons in the first six months of 1922, and 262,500 tons in 1921. The Tennessee Coal & Iron Co. is reported to have entered this field, with an annual production of 40,000 tons. The mining of chromite has ceased, as the iron ratio is less favorable than that of the ore obtained from New Caledonia. Bauxite production in the Guianas, which was stopped in 1921, is expected to be resumed in 1923.

Western Europe

By W. A. Doman
London Correspondent *Engineering and Mining Journal-Press*, 111 Queen Victoria St., London, E. C. 4.

Chaotic conditions prevailed in Central Europe during almost all of 1922, so that metal mining made no progress. To insure profitable operations, a demand must exist for the metals; industry must be in a healthy condition. In Central Europe, unfortunately, the expected revival did not materialize. To a very large extent, the delay has been due to the depreciation in the German mark, which allowed one country to manufacture at sweated-labor prices and sell at world prices. Other countries could not compete, and trade stagnated. Some of those with greatly depreciated currencies have been unable to purchase any foreign goods. But no one nation can prosper by itself; it must trade with others. Consequently, the depression has spread like a disease; and until some plan for the stabilization of the German mark is evolved, allowing other nationalities to see where they stand in regard to contracts, mining in Western Europe cannot regain its former prosperity.

The Rio Tinto company, which can produce copper more cheaply than can any other European concern, received a fair share of orders during the year, but low price of copper and competition in the pyrites market constituted a serious handicap, which the Spanish Government aggravated by the imposition of heavy export taxes. The outcome of this action was the discharge of a number of workmen, which was all the more unfortunate in view of the satisfactory solution of the strike at the Rio Tinto mines toward the end of 1920.

In the South of France, diamond drilling and prospecting are in progress on the concession of the Compagnie des Mines de Villemagne, which has a capital of 20,000,000 fr., and of which approximately 78 per cent belongs to the Russo-Asiatic Consolidated company. Drilling to the east of the mine has been continued for a distance of 4,000 ft., and there is the probability that at least 600 ft. more will be explored there. The average depth of the bores is 250 ft., but ore exists under the old mine at a depth of 600 ft. Further work is necessary before the extent of the ore can be determined. On assumptions that seem reasonable, it is anticipated that 4,000,000 tons will be developed in the main vein alone. A test plant is in course of erection, and it is hoped later to erect a first unit to handle 50,000 tons per annum.

Lead mining in England gives indications of expansion. The Weardale Lead Co., which made up its accounts to the end of September, 1922, had, during the preceding twelve months, produced 2,420 tons of dressed lead ore and 6,741 tons of fluorspar, against 1,563 tons of dressed lead ore and 6,870 tons of fluorspar in the preceding yearly period.

The revival of tin mining in Cornwall depends on the price at which the metal can be sold. Bewick, Moreing & Co., the Thomas, Paul, and other interests with a lifelong experience in the Cornish mines are convinced that many properties can be worked at a profit when the price of tin is at a reasonable level. Great distress prevailed in Cornwall in 1922, and many miners left the country.

REGIONAL SUMMARIES

Near East

BY DJEVAD EYOUB
Mining Engineer, 417 Eighth St., Brooklyn, N. Y.

THE NEAR EAST was the arena of far-reaching military activities and political upheavals in 1922. The mining industry, with the exception of coal mining in the Heraclea collieries on the Black Sea, continued to be inactive. Société d'Heracle, the chief producer of coal in this district, maintained a steady monthly output of 45,000 to 50,000 tons. The total production from this region for 1922 will be about 670,000 tons. The coal mined was used largely in Constantinople, where it brought an average price of 35s. per ton, or $7.95 at the prevailing rate of exchange.

The famous Argana copper mines, 65 kilometers northeast of Diarbekir, which have been worked for more than 2,000 years, remained almost idle; records show that between 1850 and 1916 at least 500,000,000 lb. of copper was recovered, but only small shipments to the smelter at Tokat, 400 kilometers from the mines on the road to the Black Sea, were reported in 1922. Although no detailed study of the district has been made, it is estimated that these mines, which have been worked only to shallow depths, will, when developed, produce 1,500,000 tons of ore per annum and 200,000 tons of copper.

The Mesopotamian oil fields have proved to be the real bone of contention in the Near East. Great Britain claims a large part in fulfillment of a mandate given her by the Treaty of Sèvres, which is no longer operative; in fact, it was never ratified. The Turkish Government claims that the petroliferous areas of Mosul are parts of Turkey proper and outside the mandatory territorial adjustments made after the war. Another sidelight is thrown on the already complicated situation by the recent claims of the heirs of Abdul Hamid, who owned the fields in fee simple; therefore, no matter what the political disposition of this area might be, it is claimed to belong to them as their private property. The conference held recently at Lausanne discussed this question, and it is hoped that a satisfactory arrangement will be made. This, with the general opening up of Anatolia, will offer extraordinary opportunities to American business men and engineers. The esteem with which the American is regarded in Turkey is enjoyed by no other foreigner.

Russia and Siberia

EDITORIAL SUMMARY

CONDITIONS in Russia and Siberia remained uniformly unsatisfactory and disappointing throughout 1922. The Russian Trade Delegation announced a production of about 8,500 oz. of gold from Siberia during the first four months of the year, but in June it was reported that the Soviet government had decided to stop all work at the mines.

The Russo-Asiatic Consolidated Co.—an important factor in Russian and Siberian mining—announced in September that an agreement had been signed by the chairman of the Soviet Trade Commission in London and a representative of the company. However, the Soviet government refused to ratify this, and it is evident that no appreciable amount of mining is being done in Russia or Siberia at the present time, and there is no prospect of an early resumption of operations. It is reported, however, that a dredge is working in the Chita district of what until recently was known as the Far Eastern Republic and that a small amount of gold is being exported under license.

Russian newspapers have made vague reference to the production of blister copper from the Kalata works, in the Urals, but the source of this information is not dependable. The future of mining in Russia depends largely on the attitude taken by the Soviet government toward the Russo-Asiatic company.

Far East

EDITORIAL SUMMARY

LABOR CONDITIONS improved in Burma during 1922, the Burma Mines company operating at maximum capacity and output. Tin and tungsten mining remained dormant.

The Straits Settlements continued to be an important source of the world's supply of tin, but doubt is expressed in many quarters as to the economic possibility of the introduction of modern equipment and up-to-date methods. A large proportion of the mines are in the hands of the Chinese; labor, althought inefficient, is abundant and unusually cheap.

Copper mining in Japan is not flourishing, although progressive technical developments occurred at the Kasaka works in 1922, and costs were reduced. Japan's purchases of copper from the United States for the twelve months ended June 30, 1922, amounted to 44,350 tons, which was more than ten times the amount bought during the preceding twelve months. The increase was due largely to the heavy imports in March, just before the new tariff regulations went into effect. All lead used in the country is imported, no mines being in operation. The electrolytic manufacture of zinc, so successful during the war, is also suspended.

Central America

EDITORIAL SUMMARY

THE SCHEME for the union of five central American republics — Guatemala, Honduras, Salvador, Costa Rica, and Nicaragua—sponsored to a considerable extent by Guatemala, fell through early in 1922, in consequence of the downfall of the government in power in Guatemala at that time. Nevertheless, conditions in Central America are satisfactory. The United States has granted several loans; some of the countries in question have renewed treaties of peace and friendship; and the coffee crop has been excellent. General prosperity is reflected in a year of normal running activity.

Guatemala has developed a supply of hydro-electric power, and there is talk of the development of the iron-ore deposits. In Honduras, the New York & Rosario company operated steadily throughout the year. In Costa Rica, the Aguacate company continued to mine and mill at normal capacity. The Eden Mining Co., in the Pispis district of Nicaragua, shut down in the latter part of 1922. The Rosario mine, about 20 miles from the Eden, with 1,500,000 tons of developed ore containing over 5 per cent copper, is still idle. Further expansion of the mining industries in Central America is unlikely until transportation conditions are improved.

REGIONAL SUMMARIES

Transvaal and Rhodesia

Rand Metallurgical Practice — Developments in the Far East Rand — Fine Grinding and the Abolition of Amalgamation — Problem of the Low-Grade Mines — Gold Mining in Rhodesia

EDITORIAL SUMMARY

THE OUTSTANDING EVENT of 1922 in the Transvaal was the strike and revolution in the coal and gold mines, discussed at length in the article on gold and silver mining, on page 94.

The immense importance of the gold industry of the Transvaal to the British Empire as well as to British South Africa prompts a continual criticism of existing methods of metallurgical operation at the great mines of the Witwatersrand. This is a healthy sign, although much of the comment ignores facts. Disregarding the effects of untoward happenings, such as the revolution of 1922, during recent years the district has more than maintained its position as being the largest contributor to the world's supply of gold. The actual figures are as follows: 1915, 39.7 per cent; 1916, 42.3 per cent; 1917, 44.4 per cent; 1918, 45.7 per cent; 1919, 47.2 per cent; 1920, 49.7 per cent; 1921, 52.4 per cent. Far more interest is shown in South Africa in the economics and the technology of the subject than in the United States, where output has shown a steady and serious decrease in recent years. The maintenance of output from the Witwatersrand and from South Dakota, in contradistinction to the general decline elsewhere in the United States, is contributory evidence of the wisdom shown in the retention of treatment methods that have been the object of much adverse criticism, but which the passage of time has proved to have been based on sound metallurgic knowledge and the appreciation of common-sense principles.

ORES OF FAR EAST RAND REQUIRE FINE GRINDING

The technology of metallurgical methods on the Witwatersrand received more than the usual amount of attention in 1922 in consequence of the publication of a rough outline of treatment at the New State Areas plant, now under construction, and the decision of at least one other company in the Far East Rand to discard current practice in favor of all-sliming and cyanidation. This change, apparently due to the refractory nature of the ore in that section of the gold field, has been the signal for a repetition of the campaign in favor of drastic alterations in existing methods of treatment on the non-refractory ores of the Witwatersrand. However, contrary to general impression, there has been no appreciable decline in the average recovery of gold by amalgamation in the last ten years; and, as this may be taken as an index of the character of the ore as a whole, it is unlikely that all-sliming will be extended beyond those properties in which trouble is experienced in obtaining good recoveries by methods of recognized reliability. It is unlikely, even if capital expenditure represented by existing plant equipment could be disregarded, that any alternative equipment or method of treatment would yield a higher recovery of gold at a reduced cost.

The contiguity of so many of the mines in the Witwatersrand and the gradual diminution in grade, rather then the exhaustion of ore reserves, forces attention on the subject of the compulsory consolidation of the rich with the poor. It has been suggested that the mineral resources of a region in which the distribution of precious metal in the ore is erratic might be extended considerably by the amalgamation of the low-grade mine with the adjoining high-grade mine. The extent of the total reserves of ore would thereupon be augmented, the output from the district would be increased, benefiting all but the stockholders of the rich mine, for whom it might be possible to provide compensation, commensurate to the benefit derived by the industry as a whole, to the community, and to the country. The subject merits discussion.

Transvaal Gold Output, 1917-1922, in Fine Ounces

	1922	1921	1920	1919	1918	1917
January	639,728	651,593	670,503	676,059	714,183	782,631
February		558,137	625,330	636,728	659,759	721,324
March		671,123	707,036	712,379	696,281	787,091
April	511,338	681,382	686,979	694,944	717,099	742,774
May	629,786	687,776	699,041	724,995	741,217	729,388
June	675,697	678,490	715,957	702,379	727,696	759,725
July	730,635	689,555	736,099	725,497	736,199	757,894
August	752,490	711,526	702,083	706,669	740,210	756,650
September	747,089	691,026	682,173	698,558	708,206	732,230
October	778,159	707,000	662,472	723,722	679,764	751,298
November	764,476	704,236	633,737	677,970	658,701	722,839
December	790,712	681,847	632,215	650,191	641,245	722,418

Improved conditions characterized the diamond mining industry in 1922, interest in which was heightened by a rush to the Vaal River district in the middle of the year. The Premier mine, in the Transvaal, and the Koffyfontein mine, in the Orange Free State, continued operations. Work at the Jagersfontein was resumed. De Beers maintained a small output only.

GOLD MINING IN RHODESIA

The gold mines of Rhodesia produced steadily throughout 1922, the principal ones being the Shamva, Cam & Motor, Globe & Phoenix, Lonely Reef, and Rezende. The total output for the year will show an increase over that of 1921. The Rhodesian Broken Hill mine is now producing vanadium ore on a commercial scale, and a long-time delivery contract has been secured.

Rhodesians in 1922 again looked askance at an attempt made to include their country in the Union of South Africa. The terms proposed did not include the acquisition of the mineral rights now held by the British South Africa Company.

Rhodesian Gold Production, 1920-1922, in Fine Ounces

	1920	1921	1922
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May	46,266	48,744	53,920
June	45,045	49,466	55,614
July	46,208	51,564	54,191
August	48,740	53,200	56,037
September	45,471	52,436	55,443
October	47,343	53,424	54,670
November	46,782	53,098	(a) 55,000
December	46,190	55,968	(a) 55,000

(a) Estimated

REGIONAL SUMMARIES

The Belgian Congo

Operations of the Union Miniere du Haut Katanga—Diamond Mining by the Forminiere Company—Gold Placer Development

By Sydney H. Ball
Mining Geologist, Rogers, Mayer & Ball, 42 Broadway, New York

THE BELGIAN CONGO in 1922 produced about 42,000 metric tons of copper, 222,000 carats of diamonds, gold valued at about $1,500,000, the greater proportion of the world's output of uranium ore, and about 1,200 tons of high-grade tin concentrate. It held fourth rank among the countries of the world as a copper producer, second as a diamond producer, and first as a uranium producer.

The Union Minière du Haut Katanga produced in 1922 probably over 42,000 metric tons of copper, as compared with 30,464 tons in 1921. In 1921, with the low copper market, and a transportation charge that represented 50 per cent of the cost of the metal, the company made little profit; but with the slightly better market, with larger output, with reduced transportation cost and other economies, the profits for 1922 were substantial. On June 1, 1922, it was announced that the ore reserves totaled 64,900,000 tons, of an average content of 6.65 per cent copper, of which 52,600,000 tons represented oxidized ores of an average grade of 7.3 per cent; and 12,300,000 tons, sulphide and mixed ores of an average grade of 3.9 per cent.

The chief producing mines are the Kambove, Likasi, Star of the Congo, and Luushia. Mining is largely by means of steam shovel; a portion of the ore is smelted direct, and a part is concentrated at the mill at Panda, first operated in July, 1921. The experimental leaching plant, which began running in November, 1921, appears to be successful. The smelter product, containing 95 to 97 per cent copper, 1 to 1.5 per cent iron, 1 to 1.5 per cent sulphur, and about 0.5 per cent cobalt, is refined by the Société Générale Métallurgique d'Hoboken. Experiments are being carried on in Africa to produce cobalt on a commercial scale.

One of the important developments of 1922 was the blocking out of large reserves of direct-smelting ore (17 per cent copper) at one of the company's mines, near the Lubumbashi smelter. The future for the company is bright; it is confident that copper production will increase and that costs will decrease.

In 1913 and 1915, the Union Minière company discovered uranium veinlets that cut at a high angle the copper deposits at two of its mines—the Luswishi and the Kasolo. In 1920, active development of these prospects was begun, with the result that, considering the world's consumption of uranium and radium, a large ore reserve was developed, particularly at Kasolo. The first shipments of ore, which is of high uranium content, reached Belgium in January, 1922, and in that month the Union Minière company, in conjunction with the Société Générale Métallurgique d'Hoboken, began the erection of a plant at Oolen, near Antwerp. On July 8, 1922, the first section of the plant began operations. The reserves are believed to be large, and the quality of the ore is such that low production costs, of uranium and radium, may be anticipated. Several of the American radium producers have entered into a selling arrangement with the Union Minière company, permitting them to offer radium on the American market at $70 per milligram.

The Union Minière company also operated its alluvial tin mines at Busanga and Kayumbo in 1922, the former of which in 1921 produced 600 tons of cassiterite, and the latter 25 tons. In 1921, the Geomines company produced 242 tons of tin, and began to operate its new plant in the Katanga tin fields in February, 1922. The output for the first six months of the year indicates that the total production for 1922 will prove to have been about 600 tons of cassiterite. It is probable that the production for the colony during the same period was 1,200 tons. The tin produced by the Union Minière company is treated at Hoboken, Belgium.

The Société Internationale Forestière et Minière, or Forminière company, which is operating placer diamond mines in the Kasai basin, put its greatest efforts during 1922 into improving transportation conditions and assuring an adequate food supply for its native labor, so that production may be increased. The company's output for 1922 amounted to 190,000 carats, compared with 134,000 carats in 1921. The companies with which the Forminière is associated produced approximately as follows in 1922: Beceka, 20,000 carats; Kasai, 12,000 carats. It is expected that each company will considerably increase its production in 1923. Twenty diamond mines were operated in the Kasaï basin by various diamond companies. Across the border, in Angola, a sister company to the Forminière, the Diamang, produced about 100,000 carats of diamonds from the operation of nine mines. The production for 1922 of the Belgian Congo-Angola diamond fields was therefore about 322,000 carats. Interesting diamond discoveries were made during the year in the north-central part of the colony.

In the northeast part of the colony, the Régie des Mines de Kilo-Moto, a committee of experienced colonial engineers, operated the state gold placers at Kilo and Moto, which are 90 miles from each other. The production for 1922 was probably about 2,200 kilograms (70,732 oz.) gold, of which about 90 per cent came from the placers and about 10 per cent from lodes. The total production to date of these two mines has been about 31,000 kilograms (996,672 oz.) gold. The placer gold contains about 10 per cent silver, and the lode gold 20 to 30 per cent silver. The gravel washed at Kilo carries about $2 gold per cubic meter, and that at Moto about $1. Most of the placer gold is sluiced, although at Kilo a small dredge is being operated on one of the streams. Gold veins have been found in both camps as a result of prospecting operations; lode mining began at Kilo in May, 1920, the ore being crushed in Chilean mills. It is probable that Nissen stamps were installed early in 1922. The ore so far crushed carries about 20 grams gold per metric ton. The reserve of gold-bearing gravel blocked out is equivalent to seven years' production at the present rate.

REGIONAL SUMMARIES

Australasia

Gold Mining in Victoria—Silver and Lead in New South Wales—Copper—Tin—Zinc—Iron and Steel—Oil, Molybdenum, Asbestos, Cobalt

BY PETER G. TAIT
Melbourne Correspondent, *Engineering and Mining Journal-Press*, 90 William St., Melbourne, Australia

THE VICTORIAN GOLD FIELDS are showing signs of revival. The Ajax group, at Daylesford, is attracting attention, and several companies are prospecting at Walhalla; what is apparently another promising reef has been found. The output from Bendigo is coming principally from the six subsidiary companies of the Bendigo Amalgamated Co.—now a holding corporation that manages but does not operate the mines. The Red, White & Blue company is paying dividends, having distributed £214,875 to date. The Costerfield mine, at Heathcote, Victoria, which for twenty years has been shipping concentrate to St. Helens, England, is erecting works for the production of antimony and antimonial products. Shipments for the first nine months of 1922 totaled 920 tons of concentrate, averaging 61 per cent antimony and 2.75 oz. gold per ton.

The gold production in the Commonwealth for 1922 was 758,300 oz., as compared with 757,400 oz. in 1921.

Australasian Output of Gold for First Eight Months of 1922

	Ounces
Victoria	68,909
Western Australia	351,023
New South Wales	17,375
South Australia	(a)2,000
Queensland	43,826
Tasmania	(a)3,000
Total	486,133

(a) Estimated.

The output of the Golden Mile, at Kalgoorlie, Western Australia, has been declining during recent years; the present wages (15s. per day, basic rate) are claimed to be too high to justify the continuance of development work. Tasmania's gold comes principally from the Mount Lyell mine; the Mount Morgan mine is Queensland's main source of production.

SILVER AND LEAD

Operations at Broken Hill are still restricted, pending a decision in regard to the number of working hours per week. The Broken Hill South, North Broken Hill, British Broken Hill, and Central (Sulphide Corporation) companies are raising ore. The Proprietary and Zinc Corporation companies are confining operations to the treatment of tailing and slime. The Amalgamated Zinc Co. is approaching the end of its reserves; its contract with the South company expired at the end of 1922. The South company is preparing to put its own plant in operation.

The Broken Hill company is still laboring under the award that limited the hours of work to thirty-five per week, and no stoping allowed on the third shift. This permits only those mines with large and well-developed orebodies to operate profitably. Now that the technical commission has finished its report, the companies will appeal for permission to revert to the forty-five-hour week. The medical examination required makes it difficult to obtain the requisite number of miners; and the operating companies would employ more men if such were obtainable. When work at the dumps of the Proprietary, Zinc Corporation, and Amalgamated Zinc companies is finished, about 1,200 men will be released for other work. The Broken Hill Associated Smelters, at Port Pirie, is affected by the decreased output of Broken Hill; but this has been partly compensated by the closing down of the Cockle Creek smelting works of the Sulphide Corporation. The output of the Central Mine, Broken Hill, now goes to Pirie, as well as the custom ore purchased from many smaller mines heretofore smelted at the Cockle Creek works. The smelter at Fremantle, Western Australia, which depended on the output of the Northampton mines, is closed.

The silver-lead mines in Tasmania are resuming. The principal producers are the Round Hill, in the Sheffield district, and the North Mount Farrell, which, however, is exporting its concentrates. Many smaller mines around Zeehan are also producing. The Magnet, at Waratah, the largest Tasmanian silver-lead mine, is being developed. At Finney's Hill, at Indooroopilly, a suburb of Brisbane, Queensland, about 40,000 tons of ore has been developed, and a mill and flotation unit is being erected.

COPPER

Queensland's premier mine, the Mount Morgan, is still in operation, but the future is uncertain, owing to the low price of copper and the high cost of production. It may close down until a readjustment of wages is effected. A loss is being incurred, notwithstanding the subsidy from the Queensland government.

The New Guinea Copper Mines company, in Papua, has completed financial arrangements for the erection of a smelting plant at Bootless Inlet and the connection of the Laloki and Dubuna mines by rope tramway.

Work in the Cloncurry field, Queensland, is at a standstill. Most of the rich ore is gone. The ultimate solution will probably be the erection of a central treatment plant, in which the various companies will be financially interested.

The Wallaroo & Moonta mines have been closed down for the greater part of the year. Operations were resumed a short time ago after considerable negotiation, the ex-employees of the company having expressed themselves in favor of a proposal to make 10s. 6d. the basic wage. A fresh dispute broke out on the question of the one-man drill, and work is again at a standstill.

The Mount Lyell company, in Tasmania, is one of the few concerns that have been able to continue working. The company has its own superphosphate works in Victoria and Western Australia, and is also interested in the Wallaroo-Mount Lyell (fertilizer), South Australia; the Electrolytic Refining & Smelting Co., New South Wales, and the Electrolytic Zinc Co.

REGIONAL SUMMARIES

Zinc and Tin

The Electrolytic Zinc Co. has completed construction work at Risdon, and is producing. . The output is expected soon to reach 120 tons per day. A small experimental unit has been erected at Zeehan, Tasmania. The concentrate treated at the Risdon works is obtained from Broken Hill. In addition, 222,598 tons was shipped from Port Pirie to Great Britain between Jan. 1 and Oct. 19, 1922, under contract between the Zinc Producers' Association and the British Government.

The Sardine tin mine and a group of other properties in the Kangaroo Hills field, Queensland, continues to attract attention, favorable reports having been made by well-known geologists and mining engineers. A small mill has been erected, and the Sardine company has entered the dividend list. Stannary Hills and other developed tin properties are languishing, owing to unfavorable market conditions.

The Briseis Co., in Tasmania, is embarking on a production campaign. The lode mines are mostly at a standstill; even Tasmania's big mine, the Mount Bischoff, is doing little.

Iron and Steel

The iron and steel works at Newcastle are closed down, pending a readjustment of wages and an anticipated drop in the price of coal. The Hoskins iron and steel works, at Lithgow, is the only other establishment of the kind in Australia. The Newcastle works draw supplies of iron ore from the Iron Knob deposit at Spencer's Gulf, South Australia. The Hoskins company's mines are in New South Wales; but there is talk of deposits being opened up in the Comstock district, near Zeehan, Tasmania.

Oil, Molybdenite, Asbestos, Cobalt

Oil companies are operating in every state of the Commonwealth, but the main centers are North Western Australia, Queensland, and Victoria. The only independent analyses of bore samples—on Freney's areas, Kimberley, Western Australia—showed 0.001 to 0.01 per cent of mineral oil. A company with a capital of £500,000 is being floated. Dr. Charles Milsom, from the United States, and Captain E. de Hautpick, a Russian mining engineer, are in Australia reporting for some of the companies. Both have expressed an optimistic opinion as to the prospects of finding oil.

John Fell continues to work the Newnes kerosene-shale deposits in New South Wales. Several companies are working the Mersey shales, in Tasmania; and, being convinced that petroleum exists below the shale, are spending money in boring—so far without result.

The Standard molybdenite mine, at Everton, Victoria, has recently resumed production; but whether even a rich mine, such as this is reputed to be, can earn profits at the present price remains to be seen. No wolfram is being produced. Several asbestos mines are at work, the principal ones being in the Barraba field, New South Wales.

The Mount Elliott company, in the Cloncurry field, Queensland, has erected a mill for the treatment of cobalt ore, and it is reported that the production is satisfactory. A contract has been obtained for 100 tons of cobalt, and a 20 per cent concentrate is being exported.

India

By W. A. Doman
London Correspondent, *Engineering and Mining Journal-Press*, 111 Queen Victoria St., London, E. C. 4.

NOTHING SENSATIONAL, in fact little of importance, occurred in Indian gold mining during 1922. Steady progress is being made and larger tonnages are being crushed, although the yield has declined slightly. For the first ten months of the year the fine gold recovered amounted to 322,064 oz., as compared with 325,977 oz. for the corresponding period of 1921. The Mysore company continues to be the largest producer, the present monthly average being about 10,500 oz. Next comes the Ooregum, with about 8,500 oz. monthly. Favorable developments occurred during the year in the Balagahat mine at a depth of 4,300 ft., the vein being 45 in. wide and assaying 2 oz. 12 dwt. per ton. At other points below 4,000 ft. a vein width from 18 to 45 in. has assayed over 2 oz. per ton.

By mutual arrangement, the Ooregum company is driving into the Nundydroog property at the 54th level. Information received recently showed that for 16 ft. the average width of the vein was 1 ft. 8 in., and contained 1 oz. gold per ton. This is hopeful news for Nundydroog shareholders.

Declining Production Is Feature of Industry

The Champion Reef company has again been unfortunate in the matter of rockbursts, which are of frequent occurrence; only those of serious nature are reported. In September, 1922, a fall occurred in Level 40, damaging levels 39 to 42 and choking Levels 40 and 41. Mining in this area, in consequence, was suspended. The October output of the mine was 4,313 oz., as compared with 4,914 oz. in May. The record month of the year was January, with 4,939 oz. Outputs in 1922 from the other Indian mines of note have been normal. During the last five years, the total production has declined considerably. In 1918 it was 484,674 oz.; in 1919, 461,967 oz.; in 1920, 442,472 oz.; in 1921, 390,848 oz.; in 1922 (ten months) 322,064 oz.

So far as its original property on the Anantapur gold field is concerned, the North Anantapur company has come to an end, operations now being confined to the treatment of tailing. The company has taken out prospecting licenses over three areas on a discovery of ancient workings about 35 miles from the Anantapur field. The company is also developing a copper mine, upon which it holds an option, at Chota Nagpur, in Bengal. Two shafts are being sunk to cut the veins at 200 to 300 ft., and an adit is expected to intersect the vein at about 240 ft.

The Cape Copper company, which owns a property at Rakha Hills, has come to grief, owing to losses on realization and the low price of copper, as well as to the unfavorable economic conditions that prevailed in India during 1922. Receivers have been appointed.

The Cordoba Copper company is testing a property in the Singhbum district of Bengal, Chota Nagpur. Exploration work has not reached any considerable depth, but wide veins with consistently high copper content have been disclosed, such as 4.85 per cent over 3 ft., 289 per cent over 3 ft. 3 in., and 9.68 per cent over 32 in. A western and a southern lode also exist and will be developed in due course.

CURRENT PROBLEMS

The Labor Situation

The Shortage of Skilled Help—Effect of Prohibition—Immigration Restriction —Wage Rates in Recent Years—Bonus and Contract Schemes—Progress in 1922

By Arthur B. Parsons
Assistant Editor

THE COMPLAINT is general that there is a "shortage of labor" in the mining industry; and yet Secretary of Labor Davis says there are 1,500,000 men in the United States without regular employment. If a prestidigitator in Chicago, let us say, were to produce 10,000 experienced, able-bodied, fairly intelligent, and reasonably law-abiding metal miners, who wanted to work in the mines at present wages, he could distribute them in the districts of the middle and western states, and they would be absorbed readily by the industry. No employee would be displaced, and output would be increased. If he were to produce 15,000 men answering similar specifications, they would all get jobs; but a few thousand inexperienced laborers, of whom a great many are now trying to do the work of miners, would find themselves out of employment. If he were to produce 40,000 miners who wanted to work, there would be a general clearing out of less useful men, and a substantial surplus of first-class miners would remain to form "rustling" lines at employment windows in the mining camps. These figures are not meant to be statistical; they are illustrative.

Isolated instances excepted, production and development work is restricted generally throughout the industry by inability to obtain men at the prevailing wages. Even in Arizona, where plenty of laborers are obtainable, the call for skilled miners is insistent. In some districts, a "labor shortage" is always said to exist until there is a considerable oversupply at the wages the companies feel that they can afford to pay. The employers want enough idle men in the community to make it possible to drive workmen who have jobs, with the silent threat that they may find themselves among those who haven't. The same sort of policy dictates the reduction of wages, regardless of living costs, as soon as the surplus of good men becomes sufficiently large. It is in such districts that the greatest trouble is being experienced today in getting a reasonable day's work out of the men; but those in authority apparently fail to see the obvious connection between their own policy and the attitude of the employees.

Daily Wage Scales of One or More Companies in Various Mining Districts

		Miners				Surface Labor			
State	District	Jan. 1, 1914	War Maximum	Jan. 1, 1922	Dec. 1, 1922	Jan. 1, 1914	War Maximum	Jan. 1, 1922	Dec. 1, 1922
Arizona	Globe-Miami	$3.75	$6.15	$4.50	$4.95	$2.00	$3.90	$2.75	$3.03
	Oatman	(*a*)	6.00	5.00	5.00	(*a*)	5.50	4.50	4.50
California	Randsburg	(*a*)	6.25	6.25	6.25	(*a*)	5.50	4.50	4.50
	Plumas County	4.00	5.50	4.75	4.75	3.50	4.25	4.00	4.00
Colorado	Cripple Creek	4.00	5.00	4.50	4.75 (*i*)	3.00	4.25	3.50	3.50
	Ouray	4.00	5.25	4.00	4.75 (*c*)	3.00	4.00	3.50	3.50
Idaho	Coeur d'Alene	3.50	5.75	4.25	5.00	3.00	5.25	3.75	4.25
	Salmon	3.50	5.50	4.00	4.50 (*d*)	3.50	4.50	3.50	3.50
Michigan	Copper Country	2.93	5.50	3.15	3.50	1.95	3.70	2.40	2.65
Minnesota	Mesabi Range	(*b*)	6.32	3.50	4.00 (*e*)	(*b*)	5.33	3.25	3.75
Montana	Butte	3.50	5.75	4.75	4.75 (*f*)	3.00	5.25	4.25	4.25
Nevada	Tonopah	4.50	6.00	5.25	5.75	4.00	5.50	4.75	5.00
Oklahoma	Picher	(*a*)	4.50	3.50	4.00 (*g*)	(*a*)	3.75	3.00	3.25
Oregon	Cornucopia	3.50	5.50	4.50	4.50 (*h*)	3.00	3.62	3.75	4.00
South Dakota	Lead	3.50	5.00	4.50	4.50	2.50	3.75	3.25	3.25
Tennessee	Mascot	2.75	4.64	3.06	3.06 (*j*)	1.50	3.00	2.25	2.25
	Copperhill	2.00	4.32	3.28	3.52 (*k*)	1.50	3.48	2.48	2.72
Utah	Park City	3.25	5.25	4.25	4.75	3.00	4.25	3.25	3.50
	Bingham	(*b*)	5.25	4.25	4.75	(*b*)	4.50	3.75	4.25
Ontario, Canada	Porcupine	3.50	5.28	5.28	4.80	2.50	4.24	4.24	3.76

(*a*) Company not operating.
(*b*) Data not available.
(*c*) 50 per cent of the underground men are on contract. Earnings average $7.50.
(*d*) 10 per cent of the miners are on contract or bonus. Earnings average $6.50.
(*e*) 30 per cent of the miners are on contract or bonus. Earnings average $5.25.
(*f*) 80 per cent of the miners are on contract or bonus. Earnings average $6.25.
(*g*) 80 per cent of the shovelers are on contract or bonus. Earnings average $3.90 against $3.50 for day's pay.
(*h*) 80 per cent of the miners are on contract or bonus. Earnings average $5.
(*i*) 75 per cent of the miners are on contract or bonus. Earnings average $5.70.
(*j*) 40 per cent of the miners are on contract or bonus. Earnings average $3.50.
(*k*) 44 per cent of the miners are on contract. Earnings average $4.73.
(*l*) 68 per cent of the shovelers are on contract. Earnings average $4.08, against $3.20 for day's pay.

Without trying to settle the question as to what constitutes a labor shortage, it may safely be said that, in spite of a current copper output far below capacity, there is a widespread need for competent and experienced miners. Some say that prohibition has driven the miner from the mines. But the mining camp bootlegger is no more molested than his brother in the city, nor are his prices higher. Perhaps with greater sobriety, even if enforced, the average miner sees more clearly the undesirable features of his occupation and of his living conditions. Is the better remedy to restore the booze or to improve the working and living conditions?

The restriction of immigration by federal law has doubtless had an important influence on the mine-labor situation, as it has had in other industries. If these laws are altered, a measure of relief will be automatic; but the statistics we quote from the Department of Labor indicate that something deeper than a mere lack in the net number of unemployed underlies the difficulty of obtaining men.

Where are the thousands of non-drinking, hard-working, American miners who were laid off in 1920, when all mining, except gold and silver, virtually stopped? Thousands of them have not come back since the resumption of operations during the last year. The question in a measure is answered by one of them in the *Journal-Press* of Dec. 2. He says that until necessity compelled him to get other work, he did not know that he could do anything but mine. Now he is working for $6 a day for a contractor in Los Angeles, doing rough carpentering and concrete work. The two older of his four children work in the daytime and attend school in the evenings. The family income is $324 per month, as compared with $130 if he were

to return to the mines and work twenty-six days at $5 per day. The cost of living, he says, is not one cent greater than it is at the mines. There is no comparison between the worth-while things that he and his family can get in Los Angeles and in the mining camp. Here is food for serious thought for the mine manager.

As can be seen in the accompanying table, wages were at a low ebb early in 1922, though somewhat higher than in 1914. The resumption of work in the copper and zinc mines, which was well under way by midsummer, made jobs that could not be filled, and a country-wide increase of about 50c. per day was made, voluntarily, about Sept. 1. Wages are still materially lower than the maximum to which they rose during the war. The increase had the effect of bringing more men into the industry, and the seasonal return from outdoor work with the beginning of winter has helped.

The footnote below the table indicates the average earnings under various bonus and contract schemes of payment. These are declared to work well in some places; in others, they have been tried and abandoned. The trouble sometimes is that the manager tries to regulate his payment system by studying the *payroll* instead of the *cost sheet*. The only real test of the success of any such method of payment, from the employer's standpoint, is whether more or better work is done under it for the same expenditure than can be accomplished under the day's-pay system.

The test from the employee's point of view is whether his individual earnings are proportionate to the energy, skill, and intelligence with which he does his work. Unless *both* parties find a bonus or contract system advantageous, it cannot be successful.

There is an economic limit beyond which a mining company, under the prevailing market for its product, cannot go in raising wages; in other words, at some point it can better afford to produce less than to pay more. One measure for relief of the prevailing "shortage" of competent miners is the development of more efficient equipment and the systematizing of methods and organization so as to decrease the number of men required to produce a given quantity of ore. Another is the careful and intelligent training of men so that they can work effectively. Perhaps the most important is the improvement of working conditions for employees and living conditions for their families. These things are easy to talk about; they are not so easy to accomplish. But the year 1922 has seen not a little progress in these directions among mining companies whose executives are able to look ahead.

Standardization

By Charles A. Mitke
Consulting Mining Engineer, Bisbee, Ariz.

American industry, according to the Chamber of Commerce of the United States, is spending approximately $70,000,000 annually on scientific research. About one-half of this sum is said to be allocated to laboratory research, the remainder being expended in experimental and development work in plants. As a result, approximately $500,000,000 is being saved annually in this country.

Standardization is badly needed in the mining industries, to simplify mining operations and to lower costs. It aims at the avoidance of waste and the attainment of efficiency in production. This insures maximum output with minimum waste of time, material, and energy. To promote standardization in the mining industries it is necessary to adopt labor-saving and cost-reducing equipment, to simplify and to systematize operations, much in the same manner as it is being effected by the use of cost-reducing systems in manufacturing plants.

Advantage has already resulted from the campaign carried on by a number of companies in the standardization of mine timbers. A similar effort is being made to standardize equipment and operations connected with the use of drilling machines, drill steel, and explosives. Investigations are progressing to determine the possibility of developing a small mechanical loading device for use in the prospect and development drift of average size.

One of the most insistent present-day problems has been caused by shortage of labor. Recent legislation has restricted immigration; the depression in the mining industries during the last two years has caused many miners to find employment elsewhere, and this has made the problem more acute. High wages, almost on the war basis, are being paid, although the copper market is on the pre-war standard. This is due to the fact that the cost of living is still high; the purchasing power of the wages being paid does not permit a high plane of living for labor, nor does the work done provide a sufficient margin of profit for the companies. To increase wages under present conditions would mean the continuance of operations at a loss. The only practicable solutions of the difficulty is to increase output. The standardization of operations in a mine is for the purpose of increasing the productive capacity of the workers, thereby lowering the ultimate cost of the product. Thus the workers, as well as the employers, benefit.

Although it may not be possible to double the output per worker, as suggested by one observer, it can be increased; employees can be induced to make more than their regular daily wage by the introduction of a mutually satisfactory bonus system and the establishment of first-class or "standard" working conditions. What constitutes a standard day's work in each department of mining? An answer to this question should provide the foundation upon which a good bonus system may be developed. Another important matter is the standardization of underground conditions.

Increased production, stimulated by the adoption of either the contract or the bonus system, necessitates no increased supervision; it should involve little extra expense to the companies. Suppose, in consequence of the adoption of standardization, that it is possible to effect a very small saving, even only ½c. per pound of metal produced. Taking an annual production for the copper industry alone of 1,500,000,000 lb., this would result in an annual saving of $3,750,000. If the amount could be increased to ½c., the annual saving would be $7,500,000; if to 1c. per pound (not by any means the ultimate limit), the saving then would be $15,000,000 per annum. When it is realized that such figures refer to the copper industry alone, and do not include the iron, silver, lead, zinc, or coal industries, the importance of standardization as a factor in the introduction of economies cannot be overestimated.

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Immigration and Mining

BY ROBERT LINTON
Mining Engineer, 120 Broadway, New York

THE IMMIGRANT bears the same relationship to mining that he does to other productive industries, the growth of which requires ample supply of labor, which cannot be recruited entirely from the native-born.

Even with the best utilization, a shortage, especially in unskilled labor, is inevitable, which must be met by immigration. How to provide for this without adding an undesirable element to our population presents a serious problem. A recent attempt to solve it is embodied in the "quota" immigration law, which has been in effect since July 1, 1922, and which limits the number of immigrant aliens of any nationality admitted in any fiscal year to 3 per cent of the number of foreign-born persons of such nationality resident in the United States, as shown by the census of 1910, nationality being considered as the country of birth.

It applies to Europe, Africa, Australia, and certain islands of the Atlantic and Pacific, to Persia, and to the territory formerly comprising Asiatic Turkey, but not to the Western Hemisphere, nor to the major part of Asia. In the operation of the law, no allowance is made for alien emigrants who leave the country; the 3 per cent limit is on the gross number of immigrants arriving.

Statistics seem to indicate that the law has accomplished what its supporters had hoped, placing little restriction upon immigration from those countries whose nationals are supposed to be generally sympathetic with American ideals and institutions, but limiting the influx of those immigrants that experience has proven are antagonistic to our institutions or difficult to assimilate. The detailed figures, however, reveal significant facts, which disclose serious objections to the quota principle as a basis for regulating immigration, especially as it affects American industries.

Against the total of 309,556 immigrant aliens admitted during the year, 198,712 departed, leaving a net gain of 110,844. If non-immigrant and non-emigrant aliens are also taken into account, the increase was only 87,121. This increase was made up as follows:

	Increase
Children under sixteen years old	54,211
Female adults sixteen years and over	77,113
Total	131,324
Male adults sixteen years old and over (decrease)	20,480
Net gain	110,844

The statistics covering occupations show that, of the arrivals, 32,726 are classed as laborers, against 100,058 laborers who departed, or a loss of 67,332. If non-immigrants and emigrants are counted, the loss is found to be 86,930.

The shift in alien population, therefore, resulted in an increase of dependents and a decrease of wage earners. Although this was no doubt due in part to depressed industrial conditions, the fact remains that quotas for some nationalities important for American industries were filled, whereas the population of such nationalities in this country decreased. The quota for Italy was filled, yet there was a net decrease of 12,856 Italians for the period (21 235 if non-immigrant and emigrant aliens are counted). The number of workers of those nationalities that find employment in the mines showed a considerable decrease in the aggregate.

The quota law recognizes the importance of regulating immigration, and in that respect it is a step in the right direction. But it is based on restriction, whereas the real need is for selection. In its present form, it is bound to hamper our industries in securing adequate personnel, especially with the existing provision that emigration cannot be charged against immigration in determining quotas.

Immigration should be regulated according to the requirements of the nation, which naturally vary from time to time. The pressing need at present is for a more adequate supply of unskilled labor in our industries, and the laws now on our statute books hamper rather than assist in meeting this need. The Bureau of Immigration would function much more effectively if its major work were transferred from ports of entry to countries of departure, and if immigration were so directed that districts and industries that need men will receive them, and that districts which are overmanned will not have their unemployment problems increased. With such selective control, the Contract Labor Law might well be repealed, and the literacy test, the futility of which has been demonstrated, might well be abolished. Nationality is of secondary moment; it is of vastly greater importance that the immigrant respect our institutions and customs, find useful work awaiting him when he arrives, and be assimilated in a reasonable length of time.

Mine Legislation

BY PAUL WOOTON
Special Correspondent, *Engineering and Mining Journal-Press*, Washington, D. C.

DESPITE THE FACT that Congress was in session for more than ten months during 1922, little legislation of a distinct mining character was considered, most of the time being taken up with the tariff. Nevertheless, the Fordney-McCumber Act has affected the mining industries to a greater extent than has any other tariff act before adopted. This is due to the fact that many raw materials were made dutiable, and because of the particularly high level of rates in the new act.

The prospects for legislation of interest to the mining industries during 1923 depend almost entirely on whether or not Congress is called in special session. The legislative needs of the country are so great that it is hardly likely that it will be kept out of session from March 4 until the opening of the regular session in December. If an extra session is called, consideration may be given to the revision of the mining laws, as well as to the relationship of mining to executive department reorganization.

The most important activity of Congress during 1922, other than tariff legislation, was the consideration given the Arentz bill, which provided for a revision of the mining law. The opposition to this measure, as revealed in the hearings, is widespread. The fact that some of this is based on misunderstanding does not affect the situation. It is evident that a campaign of education must be undertaken before sufficient accord can be secured to make possible the passage of such legislation.

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The Functions and Future of the Professional Organizations Within the Mining Industries

By T. A. Rickard
Contributing Editor

THE EDITOR has asked me to write on the subject of the professional organizations within the mining industry for the review number, otherwise I would not have selected it as a topic, because during the past year I have written frequently on kindred matters. I shall start by saying that few of the organizations are performing the functions that they were intended to perform when they were created; indeed, some of them did not start as 'professional' organizations, and of those that did many are no longer so restricted in membership as to belong to that category. For example, the Canadian Institute of Mining and Metallurgy was started in Quebec in 1898 by a group of mine-operators for the avowed purpose of obtaining relief from excessive taxation. The American Mining Congress was started in Colorado in 1897 to wage a campaign in favor of the free coinage of silver. It was a nondescript body of persons engaged in mining affairs. In 1905, under the leadership of Mr. James F. Callbreath, it turned to a propaganda in favor of the establishment of a Federal Department of Mines. When this purpose was fulfilled, in 1910, by the creation of the U. S. Bureau of Mines, the Mining Congress had to seek a new *raison d'être*, and found it in acting as a permanent lobby on behalf of the mining industry. This change of policy synchronized with the transfer of the Secretary's office from Denver to Washington. The Mining and Metallurgical Society of America when organized in 1909 was intended to be a highly professional organization restricted to those fully qualified, by training and experience, as mining engineers, metallurgists, and geologists. The founders were carried away by the idea of exclusiveness to such a degree that the Society failed in becoming representative, so that today it serves two functions: a delightful dining club in New York and an incubator of measures helpful to the welfare of the mining industry. The Society has made its mark, but it has failed, as yet, in becoming what it was intended by its founders, namely, a national organization of American technicians engaged in the mining industry. The failure is quantitative, not qualitative. Such an organization, national in scope, ought to include not 300, but 3000, members. The purpose of the American Institute of Mining and Metallurgical Engineers, which was founded in 1871, was to promote professional solidarity and to publish the technical papers written by its members, but in course of time it also has gone outside the mining and metallurgical professions to seek members, and in order to meet the consequent increase in expenditure it has embarked on a campaign of commercial journalism entirely foreign to the policy of its founders, who endeavored to assist, rather than compete with, the independent technical press. The Institution of Mining and Metallurgy was started in London in 1892. It resembles the Mining and Metallurgical Society of America in being restricted to a membership of professional men in good standing, and, unlike its counterpart in the United States, it has succeeded in reconciling the idea of excluding the unfit with the idea of being representative of the profession to the welfare of which it is devoted. The membership of the Institution, including associates, numbers 2000, which indicates a satisfactory representation of the mining engineers and metallurgists to whom London serves as a point of departure for mining enterprise. Its publishing activities are restrained, so that it has escaped the financial embarrassments that trouble the two institutes on this side of the Atlantic. The Institution appears to be fulfilling its avowed functions: to promote professional solidarity and to uphold a code of conduct worthy of the profession. Some members have been expelled for misdemeanors; others have been reprimanded for conduct that merited censure. The effect of this has been salutary. The publications of the Institution are not excessive in volume, but the discussions at the monthly meetings in London are interesting and agreeable.

One reason for the success of the Institution is the favorable geographic position of its headquarters. On the other hand, the geographic factor is unfavorable to similar organizations in Canada and the United States. The width of the American continent is an obstacle to solidarity. When the members of a society live 3000 miles from the head office, it is manifest that the society must operate under difficulties. The distance from Vancouver to Montreal is 2886 miles; it is 3250 miles from San Francisco to New York. The geographic detachment of the officers of the two Institutes is the cause of much of the lack of sympathy noticeable between them and the members living west of the Rocky Mountains. The effort to correct this inconvenience by electing, or selecting, Western men as directors has been a lamentable failure, because such representatives find it impracticable to attend the meetings of directors in New York or Montreal. It costs too much and it consumes too much time. The control therefore rests in the hands of those living near headquarters, and the directors in the West simply acquiesce in the decisions made by the board to which they belong nominally. The suggestion to remedy this defect by holding directors' meetings successively in different cities all the way across the continent is well-intentioned but absurd, because the result would be to change the personnel with every meeting, so that different groups of directors would attend, leaving the peripatetic president and secretary as the only links of deliberative continuity.

The annual meeting of the American Institute in San Francisco last October brought a party of 18 from east of the Missouri, and of these 8 were ladies. The attendance at the sessions did not exceed 200, out of a membership of 10,000! The meeting of the Canadian Institute at Vancouver brought a dozen members from east of the Rocky Mountains and the sessions attracted about 150 persons, out of a membership of 1500; so that the attendance compares favorably with that at

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San Francisco. It is obvious that an attendance of 2 per cent marks the failure of the American Institute as a social organization. Moreover, not ten men that were at the San Francisco meeting will attend the next meeting, in New York. In short, the meetings, whether called 'annual' or 'Western', are essentially local, by reason of geographic compulsion and lack of sympathy. For example, the meeting of the Canadian Institute at Montreal endorsed the Secretary's proposal to broaden the basis of membership, whereas the previous meeting at Vancouver had declined to sanction the proposal. The San Francisco section of the American Institute was treated as contumacious by a former Secretary because it chose to have views of its own in regard to the policy of the Institute. Therefore I say that "the future of the professional organizations within the mining industry" is likely to be marked by an increasing divergence of policy and of purpose as between those at headquarters and those on the frontiers of mining adventure.

The "future" of the "professional organizations" depends upon the performance of their "functions". The Canadian Institute is considering its secretary's proposal to lower the bar of membership so as to include all those interested in mining, which means everybody willing to pay the dues. This institute may not be a strictly 'professional' organization, but it is a technical society; now it may become a mining congress. The American Mining Congress never was a 'professional' organization, nor even a 'technical' society; it is now a lobby at Washington financed not by the mining industry as a whole, but by a group of large mining companies. It is controlled not by elected representatives of the industry but by a dozen general managers representing big capital. The Mining and Metallurgical Society is a professional organization, and one of high character; all it needs to be worthy of its name is to increase its membership until it reaches the point of being truly representative of the thousands of competent and honorable men in whose hands—and brains—lies the direction and management of mining and metallurgical operations in North America. The American Institute is neither a professional organization nor a parliament of mining men; it has lost its character as the one without gaining the comprehensiveness of the other; it cannot regain its status as a professional organization except by the death or resignation of a third of its members; therefore it faces an uncertain "future", chiefly because it has departed so far from the performance of its proper "functions". Its name is misleading because only a minor portion of its membership comes under the category of "mining and metallurgical engineers". Meanwhile it has burdened itself unnecessarily by the adoption of a policy that involves the publication of needlessly bulky and insufficiently edited transactions, and to this orgy of printing it has added an adventure into commercial journalism of a second-rate kind. Evidently the outlook for "professional organizations within the mining industry" is not good; on the contrary, at this time of writing it is darkened by divagations of policy that are destructive of usefulness in the right direction. The Institution in London and the Society in New York present the best prospects as organizations of the men engaged in the maintenance and development of the mining industry.

The Railroads and Mining

By F. R. Raiff
Traffic Manager, American Smelting & Refining Co., New York

THE LAST YEAR has shown considerable improvement in the mining industries. Many mines that were closed a year ago are now operating at or near capacity; and the improvement in conditions generally is reflected in the increased consumption of lead, copper, and zinc, and in higher prices.

The railroads have contributed in no small measure to these improved conditions, which have resulted in tonnages to and from the mines and smelters greatly in excess of those of a year ago. The railroad companies have readjusted many ore rates that were out of line, in addition to those that were reduced by order of the Interstate Commerce Commission and effective on July 1 last. Particularly have they been helpful in reducing rates on low-grade ores, the mining of which had been largely suspended during the period of high labor, fuel, and transportation costs and lower metal prices; and it is the so-called low-grade ores that constitute the principal ore tonnages being received at the smelters today.

Concentration of ores, followed to a greater extent than before, is being practiced usually at the mines, thus reducing the amount of material to be transported to the smelters by the railroad companies; but the concentrates pay a higher rate per ton because of the increased value of the product, on which the freight rates are based.

Sea Freighting Tends to Relieve Congestion

The so-called general advance in freight rates in 1918 and 1920 caused the disruption of many long-recognized freight differentials and arbitraries, all of which have not yet been readjusted; but, as the differences have been called to the attention of the proper officials of the carriers, a spirit of co-operation has been manifested in an endeavor to settle them.

The intercoastal traffic via the Panama Canal has been growing by leaps and bounds, taking from the railroads a large amount of freight. Lead and copper constitute the best possible ballast, so the steamship companies have made rates on these commodities, eastbound, that have attracted a large tonnage not only of refined metals but of bullion destined for eastern refineries. This has been drawn from refineries on the Pacific Coast, as well as from Montana, Idaho, Utah, and Nevada. It is moving through Atlantic ports to destinations as far west as Buffalo and Detroit. Lead and copper form ideal ballast for lumber cargo vessels, and many voyages are now made with these commodities as the principal cargoes.

The heavy flood of east-bound traffic that has been moving for several months has caused congestion in the industrial centers of the eastern states and a shortage of railroad equipment in the West, retarding greatly the movement of raw material to the smelters. The middle of November saw what was believed to be the peak of this heavy movement; and, with the return of empty cars by the eastern lines, this congestion should be relieved and again make available, in the West, a sufficient supply of equipment to take care of the current needs of the mines and smelters.

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The Tariff on Minerals

Economic Unsoundness of Tariff Act—Tungsten—Antimony—Manganese—Magnesite—Zinc—Lead

BY MARC PAWL

BEFORE THE FORDNEY-McCUMBER ACT was passed I attempted to show that the proposed tariff on minerals was economically unsound.[1] The act has been in operation since Sept. 21. The duty on tungsten ore or concentrates is 45c. per pound of contained metallic tungsten, or $7.14 per short-ton unit, which was about the average price of the commodity before the war, and more than 250 per cent of the present price in London, quoted nominally at 12s. per long-ton unit, or about $2.75 per short-ton unit.

The price began to rise as soon as it was sure that the tariff law would pass. It has since risen to about $8 per unit. The maximum to which it can rise, unless Chinese ore also rises in price, is about $11. And at this figure probably only three or four mines in the United States can be operated. If this be so, users are to be taxed heavily on the 15,000 tons or so of tungsten ore now held in this country. Late in March, 1922, a capitalist gave a broker orders to buy, store, "and forget for the present" all ore obtainable at $2 per unit. He can now afford to erect a monument to a munificient Congress!

No tariff was placed on antimony ore, for we produce none. The imported metal was taxed at 2c. per pound, for there are several smelters. But tied to antimony is a story of one of the most absurd tariffs yet passed. An American firm began making antimony oxide several years ago, when the domestic consumption was only about 200 tons per annum. The demand was stimulated so that this increased to 2,000 tons a year, when the bill in question came up for consideration. Needle antimony from China (the liquated stibnite), costing about 2¼c. a pound c.i.f. New York, was used as the raw material.

When the committee decided to recommend a tariff of 2c. per pound on metallic antimony, an American representative of a Chinese firm immediately went to Washington and advised the committee that a tariff should also be put on needle antimony, but that none should be put on the oxide. The recommendations were adopted, and a duty of ¾c. per pound was placed on crude or needle antimony. To show how this affected the American manufacturer, let me quote Gordon L. Burk, clerk in the American consulate at Changsha, Hunan, the great antimony center. Under date of July 22, 1922, he wrote that "The richest mines and the ones that cost the least to operate are being exploited to their full worth. . . . Since the demand for regulus has fallen off, antimony ore is manufactured into trioxide, commonly called antimony oxide." Thus, when the largest antimony mines in China were turning all their product into oxide, a tariff was placed on the raw material needed by the American manufacturer, whereas the competing product was put on the free list!

Since the passage of the Fordney-McCumber Act, the price for needle antimony, c.i.f. New York, has been 4⅛ to 4¼c. per pound, with Chinese antimony oxide at 4¼c. per pound, c.i.f. New York. It is easy to see what will happen to one American industry under legislation of this type.

The duty of 1c. per pound on the contained manganese in ore carrying more than 30 per cent manganese was almost as absurd. It was fixed on the representation of the proponents that the figures of the U. S. Geological Survey, showing the reserves of manganese ore in this country, were out of date, and that only those pleading for a tariff were capable of giving correct estimates. One of the principal witnesses testified that data for 1913 were used in a report issued in 1921,[2] yet the report contained the tables referring to world production in 1918. Apparently no Senator thought of looking into the report to see whether the statements made were true, nor was the Survey called on to account for such alleged laxity. It is fair to say that much of the testimony was of the same type. The duty was imposed, but high-grade manganese ore must still be imported, as the government geologists forecast. The only difference is that the ore costs more.

The magnesite tariff, ⅜c. per pound on crude, §c. on caustic, and 23 to 40c. on dead burned, was passed almost entirely for the benefit of one firm, although there were nominally others, and against the interests of other firms which probably had more unamortized American capital invested in magnesite deposits abroad than the proponents had in the United States. In August, 1922, prices were quoted as $8 to $12 per ton for crude, and $30 per ton for calcined magnesite; in October, the month following the passage of the new tariff act, the prices were $15 for crude, $37.50 for calcined, *f.o.b. California;* but most of the steel works using the material are situated between Chicago and Pittsburgh, and the freight thence from California or Chewelah, Wash., is $15 per short ton. These prices are to be compared with Grecian "caustic" at $17.50 to $20, and Austrian dead burned at $16.15 to $16.25 in New York, in 1913, before the war and before the tariff. These prices would again hold but for the tariff.

Zinc, in August, 1922, was quoted at from 6.18 to 6.30c. per pound in St. Louis. The tariff bill placed a duty of 1¾c. per pound on metallic zinc, and ½c. to 1½c. per pound on zinc in ore. In October, the price was 6.66¼ to 7.045c. per pound. In the tariff on zinc and zinc ores we have the spectacle of a heavy duty on a material that we are exporting constantly.

Lead was 5.75 to 5.90c. per pound in August and 6.38 to 6.50c. in October. We have a tariff of 1½c. per pound on lead in ore, and 2½c. on lead in bullion—we have put that much of a premium on the early depletion of our lead deposits, despite the fact that no large lead mine has been discovered in ten years.

[1] Pawl, Marc. "The Tariff on Minerals," *E. & M. J.*, June 11, 1921; *Chem. & Met.*, June 8, 1921.

[2] Tariff, Schedule 3—Metals, and manufactures of. Hearing before the Committee on Finance, U. S. Senate, 67th Congress, Aug. 26, 1921, p. 1916.

CURRENT PROBLEMS

Taxation

Aggregate Amount To Be Raised—Extravagance or Economy in Governmental Administration—Method of Levy—Distribution of Revenue

By Henry B. Fernald
Loomis, Suffern & Fernald, Certified Public Accountants,
54 Wall St., New York

THE condition has passed that existed a few years ago, when, by devising new taxes, it was a comparatively simple matter to accumulate surplus revenues that invited governmental extravagance. Durin 1922 it was a difficult matter for our governments—federal, state, and municipal—to raise revenue required to meet expenditure. In spite of this, a demand has continued for increased expenditure for existing activities, and added expenditure for new activities. This demand has come (1) from those who, for political purposes, have advocated or promised expenditures without thought or regard for the source from which the necessary funds might be derived; (2) from citizens or organizations that, carried away by a selfish or a worthy motive, have urged greater activities along the lines in which they were interested, regardless of cost; (3) from governmental agencies, government officials and employees, who, perhaps for selfish reasons or perhaps because of their interest in their own occupations, have argued and pleaded for increasing expenditures.

There has been little aid and co-operation on the part of citizens in bringing about governmental economies. A strong undercurrent of protest has been in evidence against high taxation; in some cases, proposals authorizing bond issues have been defeated at elections; but thousands of citizens who protest against heavy taxation will sign petitions or join organizations to urge new activities and greater expenditures.

The basic problem of taxation is the problem of governmental expenditures. Reduced taxation is impossible without reduced expenditures. Even though the growth of existing activities is sternly repressed, a high tax rate will continue. Our bonded indebtedness alone will require vast sums from taxation for almost a generation, even if no new bonds are issued. Tax rates, therefore, must continue high for many years, unless a radical change can be made in the activities and methods of our governments.

How to do this is the fundamental problem of taxation today. Government economies are sometimes forced by a reduction in available revenue, which, however, normally results only from business depression or some other form of drying up at the source. It is seldom a consequence of the voluntary action of governing bodies. Argument in favor of reducing taxation usually comes from some special class of taxpayer; it is, therefore, subjected to attack as being tinged with special interest.

The only effective method to bring about reduction in government expenditures seems to be by the intelligent study and consideration of the nature, purposes, and results of such expenditures; by the criticism of what is unnecessary and extravagant, and by the devising of means by which a reduction can be economically and efficiently accomplished. This requires a study of and attention to government affairs that the ordinary citizen is loath to give. It is much easier for him to shift the responsibility, and then criticize the failure to solve a problem whose solution he himself is unwilling to attempt. The first requirement is that the citizens—of towns, counties, states, and of the nation—should appreciate that there can be no solution of the tax problem until they as individuals are prepared to give their best efforts to solve the problem of reduction in expenditures. This is a common problem for all of us.

Whatever may be the aggregate amount to be raised by taxation, a divergence of interest arises between various classes of taxpayers as to the methods of distributing the tax burden. Even when all taxes are raised by a single method—as, for example, by taxation of real property—it is difficult to avoid inequalities. Even in a single town or city it is not easy to assess all real property equitably; it is more difficult to get the assessments made on the same basis in different towns and different counties, to say nothing of different states. It is almost impossible to get different kinds of property in various jurisdictions so assessed that each will bear its fair share of tax.

Further difficulty arises when two main systems of taxations are introduced as in this country—(*a*) a tax based on property valuation; and (*b*) a tax based on income.

The tax on property valuation may be a tax on real property, a tax on personal property, a tax on value of corporate assets, an inheritance tax, or any other kind of tax based on a valuation of the property. The tax on income, similarly, may take varying forms, such as the recognized federal and state income taxes, and the occupational, franchise, or privilege taxes. We may also group under this heading all tonnage or severance taxes which are based on taxation of mineral products when sold, even though the levy be made at a flat rate per ton.

Taxes are usually presumed to be distributed (1) on the basis of benefits received; or (2) on the basis of ability to pay. Almost any tax can find justification on one of these two grounds; but the fairness of taxation can be determined only from a comparison of the resulting tax levied against the different taxpayers. There are so many conflicting conditions and interests, and the whole subject is so tinged with political considerations, that it becomes almost impossible to formulate principles or rules for general application.

The best that can be expected in any locality or by any taxpayer is that the plan of taxation will not result in glaring inequalities. This part of the problem is, therefore, one that must be worked out by the taxpayers themselves in a fair spirit of mutual agreement and concession. The problem will never be rightly solved if it is left as a subject of discussion and argument by politicians and agitators.

CURRENT PROBLEMS

Foreign Trade in Non-Ferrous Metals and Minerals

Exports and Imports—Effect of the Tariff Act—Foreign Trade in Copper—Statistics

By Felix Edgar Wormser
Assistant Editor

THE RECORDS of the foreign trade of the United States, collected by the Bureau of Foreign and Domestic Commerce for part of 1922, are an eloquent testimonial to the improvement that has taken place in the non-ferrous metal and in the mineral industries during the year. Thus the exports and imports of copper during 1922 were heavier than for 1921, denoting increased activity by the South American and African mines, by the Atlantic seaboard smelters and refineries, and an improved demand for copper from Europe. Chile and Peru continue to pour heavy tonnages of blister copper for refining into the United States, and Germany and France remain the chief consuming countries in Europe. German purchases of American copper show a tendency to diminish, but those of France have increased.

Although copper is more dependent upon export trade than any other metal, and copper export figures are closely watched as a guide to market conditions, import figures of other mineral commodities also furnish a valuable index to industrial conditions in the United States. For example, the imports of asbestos in 1922 were about 50 per cent more than they were in 1921, indicating a business revival in those industries, spinning or otherwise, using asbestos. Likewise, tin imports showed a large jump, reflecting the better condition of the tin-plate industry.

The figures herewith are not complete enough to give the effect of the Fordney Tariff Bill, which was not enacted until Sept. 21, 1922, and the passage of which has delayed the compilation of foreign-trade statistics. The new tariff on zinc, so far as imports of zinc are concerned, has not been influential in affecting foreign trade in that metal. It will be observed from the statistics that imports of zinc during the first nine months of 1922 were much lighter than for the previous year. On the other hand, exports were unusually large.

Movements of Metals To and From the United States

I—Copper

	1921	Nine Months Ended Sept., 1922
Copper Imports, in Pounds		
Ore, concentrates and matte	102,799,920	75,532,370
Of which Chile sent	41,860,767	32,740,540
Cuba sent	17,956,450	17,293,134
Spain sent	5,164,000	6,159,180
Unrefined blister, pigs	171,735,279	185,355,896
Partly from Peru	72,016,070	61,366,500
Canada	22,073,730	34,365,900
Mexico	16,450,110	22,693,455
Africa	4,890,520	22,447,880
Chile	39,242,226	19,933,500
Refined and old metal	75,897,422	95,860,450
Total	247,672,700	356,758,716

	1921	Eleven Months Ended Nov., 1922
Copper Exports, in Pounds		
Copper and manufactures	628,446,688	691,261,138
Partly to Germany	233,072,479	178,658,835
France	98,731,640	124,859,260
United Kingdom	62,334,868	65,405,840
China and Japan	59,170,325(a)	80,787,457

(a) Japan alone

II—Zinc

	1921	Nine Months Ended Sept., 1922
Imports in Pounds		
In ore	5,410,580	3,620,440
In blocks, pigs and dust	13,562,620	272,763
Exports in Pounds		
From domestic ore	3,505,400	48,855,129
From foreign ore	1,280,253	2,698,915
Dross	1,020,365	16,608,198

III—Lead

	1921	Nine Months Ended Sept., 1922
Imports in Pounds		
In ore and bullion	85,967,867	116,747,770
Pigs, bars and old	62,602,534	4,999,512
Exports in Pounds		
From domestic ores	3,247,294	9,624,555
From foreign ores	49,425,708	56,464,400
Manufactures	.....	6,456,634

IV—Gold, Silver, and Platinum

Imports	Gold	Silver	Platinum Ounces
1921	$691,248,297	$63,242,671	62,004
1922 (11 mos.)	248,730,108	62,959,083	72,428
Exports			
1921	$23,891,377	$51,575,400	3,272
1922 (11 mos.)	34,165,303	55,894,086	(a) 1,767

(a) Nine months ended Sept. 30, 1922.

V—Exports of Minor Metals and Minerals

	1921	Ten Months Ended Oct., 1922
Aluminum, including manufactures, lb	2,196,108	7,761,729
Asbestos, tons	464	267
Bauxite, tons	5,942	14,963
Borax, lb	4,063,683	12,507,837
Sulphur, tons	285,762	442,904
Clays, tons	42,361	35,370
Phosphate, tons		
High-grade hard rock	182,594	181,060
Land pebble	544,425	410,073
All other	6,714	4,144
Iron ore, tons	440,106	601,077
Nickel, lb	425,851	2,493
Platinum, including manufactures, oz	3,272	1,767
Graphite, including manufactures, lb	1,842,158	1,660,522
Quicksilver, lb	29,501	20,120
Salt, lb	219,126,247	222,748,327
Mica, lb	.....	981,896
Tin, lb	2,308,526	1,591,831

VI—Imports of Minor Metals and Ores

	1921	Nine Months Ended Sept., 1922
Aluminum, lb	30,577,790	31,482,893
Antimony, lb	21,153,331	15,669,518
Arsenic, lb	6,686,570	6,583,674
Cobalt, lb	46,100	32,114
Iridium, osmium, palladium, oz	16,218	10,561
Chromite, tons	81,836	62,198
Manganese ore, tons	401,354	327,537
Tungsten ore, tons	1,441	1,655
Monazite, lb	542,130	672,000
Nickel, lb	2,042,178	331,272
Tin ore and oxide, tons	13,696	10,197
Bars, blocks and pigs, lb	54,201,481	94,029,801
Iron ore	315,768	662,418

VII—Imports of Non-Metallic Minerals

	1921	Nine Months Ended Sept., 1922
Abrasives, corundum, tons	1,496	1,357
Asbestos, tons	64,698	86,573
Chalk, tons	56,192	83,218
Magnesite, tons	52,483	112,159
Nitrate, (soda) tons	369,173	323,407
Potash (hydrate) lb	10,910,400	11,537,057
Fluorspar, tons	5,560	18,685
Meerschaum, lb	1,743	5,552
Mica, lb	466,513	479,127
Gypsum, tons	242,224	235,955
Graphite, tons	7,496	8,357
Pyrites, tons	216,229	170,743
Talc, lb	22,911,226	28,440,074
Mineral wax, lb	8,548,542	7,182,140
China clay, tons	146,452	185,178
Blue clay and bauxite, tons	31,575	22,219

MARKETING AND STATISTICS

Copper

Improvement in Market Conditions—Diminution in Stocks—Appreciation in Price —The World's Supply—Summary

By Joseph Clendenin
Manager, Sales Department, Guggenheim Bros., 120 Broadway, New York

THE YEAR 1922 closed with copper remarkably strong in all the world markets, due to an unexpected and sensational demand. Consumption is now well ahead of current production. No stock of marketable copper exists apart from that held in this country, which is concentrated in strong hands, and in all probability most of it is sold for delivery in the early months of 1923.

From April 1, 1921, to April 1, 1922, the production was curtailed by suspension of work at most of the American mines and as well at some of the mines in Australia and Japan. The effect of this, however, was offset in large measure by the marketing of the supplies of war brass and copper scrap held abroad, which were offered by speculators at bargain prices and sold in this country, in England, and in Germany. The total stock will never be definitely known, but according to available statistics it exceeded 800,000,000 lb. Most of it had gone into consumption by the early fall of 1922, and all of it has now disappeared. In addition, 750,000,000 lb. of primary copper in marketable form has been depleted steadily in the last twenty months, during which the reduction aggregated about 462,000,000 lb. Conditions in the industry at the beginning of 1922 were not good, the sales falling short of current refinery production by about 25 per cent; but some of the mines were reopened, and production began to reach the market in the spring months, gradually increasing as fast as labor and supplies could be assembled. The stock is now more nearly normal than it has been at any time in the last four years. The industry recovered its position in March, and demand continued satisfactorily, with occasional lapses, to the end of December, exceeding last year's business by over 50 per cent. For 1922, the production promises to be about 1,900,000,000 lb.

Copper Supply and Demand

The world's supply of copper is now coming from the United States, 62 per cent; South America, 17 per cent; Japan, 5 per cent; Mexico, Canada, and Cuba, 5 per cent; Europe (chiefly Germany and Spain) 5 per cent; South Africa, 4 per cent; Australia, 2 per cent. Mine production in this country is being pushed to the limit of labor supply; South America has increased output considerably; in other countries there is little change. The export demand has come from Germany, 35 per cent; France, 20 per cent; the Orient, 12 per cent; England, 12 per cent; Italy, 11 per cent; Belgium, 6 per cent; elsewhere, 4 per cent.

Consumption is now at a record rate in this country; all wire, brass, and sheet copper mills are working to a capacity that is limited only by available labor supply. Capacity operation throughout the winter is assured. Should the 1923 bookings open up in March at anything like the rate of March, 1922, and should the foreign demand develop as it now promises to do, the producers may find it difficult to supply the metal in the quantities called for. The demand is excellent here, and good from Germany, France, Italy, and Scandinavia. It is not so good from England, although steadily improving. With a stabilized exchange, or even a promise of it, a demand from Europe will arise for enormous quantities of copper. European countries are buying largely, even under present conditions, but not in proportion to what they need, and must buy when the money is available to pay for it. The German mills are busy on export orders, for which they can compete regardless of the exorbitant price they must pay for the copper, in marks, because of their low labor cost which represents a large part of the cost on export orders. They get foreign currency in payment for their exports, which in turn enables them to pay cash for the copper. The low value of the mark operates the other way on copper-made articles for domestic consumption, a trade that has fallen off considerably.

Immediate Future of the Copper Industry Is Encouraging

Conditions in the copper industry at the close of 1922 can be summarized thus: War scrap has been utilized. The cheaper substitutes, having been tried and found wanting, are being replaced with copper. Most of the stock of marketable copper existing at the end of 1922 has been sold for delivery in the first quarter of 1923. Current consumption is in excess of current production. Stocks at mills in the United States are normal; foreign mills have no supplies. The opinion is general that copper is in a strong and stable position.

Monthly Price of Copper, 1921-1922

	New York Electrolytic		London Standard		London Electrolytic	
	1921	1922	1921	1922	1921	1922
January	12.597	13.465	70.964	65.226	79.119	72.321
February	12.556	12.864	70.925	60.250	75.925	66.125
March	11.976	12.567	67.565	59.245	71.190	65.739
April	12.438	12.573	69.381	58.799	71.786	64.028
May	12.742	13.111	73.196	61.092	74.298	66.554
June	12.697	13.575	71.852	61.988	75.682	69.333
July	12.170	13.654	71.155	63.137	75.286	70.321
August	11.634	13.723	68.614	63.784	72.705	69.932
September	11.948	13.748	67.977	63.113	72.295	70.917
October	12.673	13.632	67.327	62.773	73.476	70.693
November	13.035	13.598	66.614	62.795	74.386	70.216
December	13.555	14.074	66.706	63.276	74.525	70.132
Year	12.502	13.382	69.356	62.123	74.223	68.859

New York quotations, cents per lb. London, pounds sterling per long ton.

The outlook for 1923 is decidedly encouraging for the producers because of the advancing price, and for the fabricators because of the better margins they are getting on their products.

MARKETING AND STATISTICS

Lead

Market Conditions and Causes—Price Changes in 1922—Mexican Lead —Probable Demand in 1923—Lead-Consuming Industries—Price Trend

By Irwin H. Cornell
Vice-President and Sales Manager, St. Joseph Lead Co., New York

THE PRICE OF LEAD in December, 1921, was 4.70c. per pound, New York; in December, 1922, it was 7.25c., indicating a large but necessary increase. The latter price may seem high in comparison with pre-war figures, but the average for 1920 was almost 8c. per pound. Before considering the outlook for 1923 let us analyze the present market and its causes. From a statistical standpoint, 1922 started inauspiciously. Great stocks of lead in finished and partly finished forms were stored at nearly all the smelting plants of the country. The redeeming features of the situation were the indicated betterment in general business, particularly among the industries consuming lead, and reduced production. Lead mines, like all other similar activities, are always slow to curtail production, and often as slow to resume.

There was no promise of prosperity for the lead producer during the six months ending March 31, 1922. The price curve for this period was almost a straight line, and during the first quarter of the year no reduction occurred in the stocks. Commencing with April, however, the situation changed. Demand increased, stocks were liquidated, and the price rose steadily, except in July, until the end of the year.

The increased demand during the latter half of 1922 arose because three great lead-consuming industries were active at the same time. Heretofore, the lead consumption by the paint industry has varied inversely with general industrial activity. But this condition changed; and the paint, the storage-battery, and the cable manufacturers have all been extremely busy. Demand has taken the domestic production, and, in addition, 5,000 tons of Mexican lead per month, in spite of the fact that domestic production for the last three months of 1922 equaled that of any quarter since the record years of 1916 and 1917.

The production in Mexico increased greatly; but, owing to the fact that Europe has been an active bidder in this market, only about one-third of the production has come to the United States to stay, the remainder being shipped directly from Mexico to England or the Continent, or else to New York to be refined in bond and re-exported.

Another important element that has affected the supply, and therefore the price, is the reduction in the world's accumulation of shrapnel balls. Although a large amount remains unconsumed, the end is in sight.

Taking the industries in the order of their importance to the lead mines, paint pigments should be considered first. Two years of excellent business have been experienced by the American corroders, and history would indicate that the demand for paint should ease off during 1923. Nevertheless, many corroders feel that white lead, in spite of competition, has attained a position in the paint industry that it will never relinquish, and that a production schedule about equal to that of 1922 will be justified in 1923. It would seem advisable, however, to anticipate a slightly smaller consumption of white lead.

The storage-battery industry should use more lead in 1923 than it has in any previous year of its history, if the improvement in general industry continues. The outlook for the manufacture of lead-incased cables is excellent. Many factories have booked orders for almost their entire 1923 production, and a record business year is expected. The increased demand for plumbing supplies will probably continue throughout 1923 if the present building program is carried out.

Sheet lead was in poor demand in 1922, although during the latter half of the year some improvement was noticeable. No further expansion can be expected unless the chemical trade becomes active. The demand for sporting ammunition, bearing metals, foil, and other miscellaneous lead products became more active during the latter half of 1922. This improvement will probably continue through 1923. From the encouraging outlook in the lead-consuming industries, it seems probable that consumption in 1923 will be large.

In considering the supply of lead, it is necessary to look at the world situation. The three important lead-producing countries outside of the United States are Spain, Mexico, and Australia. The Spanish output has been small for many years, but under the influence of a higher price (£26 per ton, London) the output should increase. Mexico is now producing lead in large quantities, all of which could be imported into the United States at the present price, provided the European demand was satisfied from elsewhere. The production in Australia is increasing and should be considerably greater in 1923 than it was in 1922, provided labor trouble does not interfere.

It would seem that the United States in 1923 will use more lead than it will produce. The domestic market, as at present, will be partly supplied from Mexico. The new tariff, which protects the American miner from foreign competition when the American price is near cost, and yet permits a large consumption of Mexican lead in this country at the present price level at a profit to the Mexican miner, will probably not permit much Mexican lead to be sold at a profit in the United States under 5½c. per pound, duty paid.

Sometime in 1923, the purchases of silver by the government, authorized under the Pittman Act, will be completed. It is believed that lower prices for silver will reduce the lead production of the Rocky Mountain states.

It seems probable, therefore, that the present price level will rule in the United States until, for economic reasons, a sufficient amount of Mexican lead is imported to reduce prices in New York to a point that would restrict the exportation of Mexican lead into this country.

MARKETING AND STATISTICS

Zinc

Production and Demand—The Brass Industry—Zinc Oxide Requirements—Growth of the Automobile Industry—Galvanizing, Past and Future—Forecast

By E. N. Hickman
Executive Sales Department, The American Metal Co., Ltd.,
61 Broadway, New York

IN AN ARTICLE published in *Engineering and Mining Journal* of Jan. 21, 1922, a statement was made that exports of zinc from this country might take place to meet foreign demand, and that the outlook was unusually promising. The price of zinc in January, 1922, was about 4.75c. per pound, East St. Louis; unsold stocks were over 65,000 tons, and consumption was less than 25,000 tons per month. By the end of 1922, zinc had nearly doubled in price, stocks on hand represented scarcely a two weeks' supply, and thousands of tons of the metal had moved to Europe to meet a critical shortage.

To what extent have the developments of 1922 corrected the inconsistencies of the zinc situation, and what developments may logically be expected in 1923? The position of Europe requires particular attention. Although the world's production of zinc in 1921 was less than half that of the last "normal" year, 1913, the principal decrease occurred abroad; North America produced about 350,000 tons in 1913, and 240,000 tons in 1921; whereas the production of the rest of the world fell from 760,000 tons to 260,000 tons during the same period. Continued low production in Europe in 1922 explains the present shipments of zinc thither from the United States. Ore, particularly Australian sulphide, is not lacking; but Europe is hampered by inadequate roasting capacity. It is safe to estimate that Belgium can produce only 65 per cent of her pre-war maximum; Germany and Poland, less than this percentage. High metal prices are, of course, correcting this, and working to restore the pre-war equilibrium—the independence of Europe and America, respectively, in regard to supplies of zinc. It is conservative to estimate that such equilibrium will be restored by the late spring or the early summer of 1923. In the meantime, further demands from Europe for American metal are possible, depending on the rate of industrial recovery there and the outcome of political and economic developments.

The outlook is clearer in the United States. We are nearing a point at which ore production will be adequate for present domestic needs. Current consumption requires approximately 40,000 tons of zinc per month, and current prices insure this. Any appreciably greater production, however, is unlikely. There is a bare sufficiency of labor; and although the usual seasonal increase is now in progress, the outlook is for renewed stringency for spring and summer, and, consequently, continued high costs. If one could foresee how the government will solve the immigration problem, it would be possible to speak with more certainty. Conservatism is the order of the day; and the penalty of overproduction is still too fresh in producers' minds to permit an early repetition of that mistake.

The brass industry is in an excellent condition; it is recovering rapidly the ground lost when its products were being used almost exclusively to meet the demands of war. The Copper and Brass Research Association has helped to bring about this change. Some brass manufacturers deplore the high price of zinc, and claim that it will prove a deterrent to consumption; yet, when one considers the relation of the cost of finished brass goods to the mixture cost and the proportion of zinc in the latter, it is plain to see why the majority of brass makers think that the consumption of their products is little, if any, affected, whether zinc is selling at 6½c. or 7½c. There is also a good outlook for sheet zinc, and a consumption in 1923 considerably exceeding that of 1922 may be expected. A brisk demand is expected for zinc oxide. Paint men are optimistic; and the outlook for rubber-tire manufacturers is also good, one authority estimating that the industry will consume in 1923 the equivalent of 6,000 tons of metallic zinc more than in 1922.

A decided decrease in demand in the galvanizing industry occurred toward the end of 1922, when the market was feeling the effects of heavy European buying; and rose above 7c. per pound, East St. Louis. Impartial advices indicate that this was due to a disposition on the part of the galvanizers not to contract ahead in the face of an unremunerative margin of 1c. between black and galvanized sheets—a differential maintained by the Steel Corporation in its schedule for the first quarter of 1923. It is understood that the Corporation's present bookings of galvanized products take care of its full capacity for the first quarter of 1923, which promises, on the basis of contracts already let, to be a year of great activity. The pipe, wire and retail-products galvanizing business is in excellent condition, which may be expected to continue.

The zinc situation is sound; production in 1923 is not likely to exceed consumption; the galvanizers are not overstocked; plentiful business is in sight if costs do not rise; other consuming lines are active. In short, the industry is facing a recovery from the depression of the last two and a half years.

Average Price of Zinc, 1919-1922

Month	St. Louis 1919	St. Louis 1920	St. Louis 1921	St. Louis 1922	London 1919	London 1920	London 1921	London 1922
January	6.922	9.133	5.413	4.691	56.045	58.643	25.262	26.321
February	6.273	8.708	4.928	4.485	46.150	61.338	24.850	24.213
March	6.150	8.531	4.737	4.658	38.500	53.467	25.077	25.467
April	6.114	8.184	4.747	4.906	36.188	47.388	25.530	26.576
May	6.079	7.588	4.848	5.110	35.477	45.088	26.923	27.304
June	6.551	7.465	4.421	5.346	36.763	41.193	26.750	27.893
July	7.523	7.720	4.239	5.694	41.815	41.886	26.262	29.042
August	7.439	7.835	4.186	6.212	39.338	41.220	25.068	31.170
September	7.160	7.661	4.235	6.548	40.935	39.690	25.256	31.750
October	7.473	7.150	4.605	6.840	43.630	39.756	26.315	34.528
November	7.827	6.247	4.665	7.104	46.588	35.028	25.949	38.011
December	8.350	5.824	4.837	6.999	53.101	27.762	26.900	37.757
Year	6.988	7.671	4.655	5.716	42.879	44.372	25.845	30.003

St. Louis, cents per pound. London, pounds sterling per long ton.

MARKETING AND STATISTICS

Gold

Declining Output—Improvement in Exchange—Wages—Imports—Expediting Return of Depreciated European Currencies

By H. N. Lawrie
Managing Director, American Gold and Silver Institute, Washington, D. C.

THE PRODUCTION OF GOLD in the world declined from $468,724,918 in 1915 to $329,915,101 in 1921. An indicated decline of $23,000,000 in Transvaal production, partly offset by an estimated increase of $7,000,000 in Canada's output, with small losses and gains elsewhere, will bring the world's total gold production for 1922 to a new low level of about $315,000,000. The production of gold in the United States declined from $101,035,700 in 1915 to $50,067,307 in 1921. A recent survey indicates a slight increase in the production for 1922, due principally to a larger amount of gold recovered from base-metal ores.

Confronted in the latter part of 1921 with a marked improvement in sterling exchange, materially lessening the currency premium, Rand operators were forced to readjust wages, which resulted in a strike during the first three months of 1922. On Dec. 13, the London gold quotation was 88s. 5d. per ounce, a premium of less than 4 per cent and the lowest since July, 1919, when permission was granted to export newly produced gold. Should sterling go to par, thereby terminating the currency premium, it is evident that the gold-mining industry of South Africa will be forced to bear the full burden of costs, now reported to be 40 per cent in excess of those of 1913, making it still more difficult to maintain output.

When prices began to decline rapidly in the last quarter of 1920, many domestic gold producers were hopeful that pre-war cost levels would make possible the early resumption of operations in properties that had been closed down during the period of high costs. The wholesale index number of the Bureau of Labor Statistics was 147 in 1921, as compared with 100 in 1913, and wages remained at a still higher level, for the reason that retail prices and the cost of living resisted, in a greater degree, the forces of deflation. Consequently, the cost of production remained considerably higher than the 47 per cent increase over 1913, as indicated by the index number. It is evident that the decline in cost of production did not stimulate the industry, inasmuch as the production of gold in 1921 was less than in 1920.

The index number was 138 in January, 1922, the lowest since the peak of inflation, but by November it had advanced 18 points. Recent wage increases in the railroad, steel, and coal industries have forced corresponding increases in the metal-mining districts, thus adding to the cost of gold production. A study of interest rates and other economic factors indicates that the price index has not yet reached its maximum height.

Under these conditions, the reopening of mines, many of which have been shut down since 1917, must be deferred. As time passes, the cost of reconditioning mines and plants increases; and, unless governmental aid is provided, many mines will have to be abandoned.

Net imports of gold for the fiscal year ended July 30, 1922, amounted to $440,972,991, a decrease of $64,048,912 from the net imports in 1921. The Secretary of the Treasury, in his annual report, makes the following comment concerning the reduction: "Among the factors which have contributed to the reduction in gold imports are: (1) The decline in this country's so-called favorable balance of trade; (2) the gradual exhaustion of the supply of foreign gold available for export; (3) the cessation of gold importations by the Federal Reserve banks (during the fiscal year 1921 over $100,000,000 in gold previously held for their account by the Bank of England was transferred to this country); (4) a reduction in foreign gold production, due largely to strikes; (5) the increased absorption of gold by India and other countries of the Far East; and (6) the increase in the volume of foreign securities sold to American investors."

The Secretary of Commerce, in his annual report, forecasts a loss of gold by excess exportation in the near future in the following statements; "The gold situation in the world is a matter of a great deal of economic thought, and no doubt the heavy drain to America has contributed to the instability of foreign currencies, not only by the diminution of their essential guaranties but also by the fluctuation of exchange involved in liquidating trade balances in this fashion. . . . Our surplus gold amounts to over $700,000,000. While this is an asset, it, nevertheless, would be more advantageous to us if it were in active use abroad. . . . There is a steady increase in the ratio of imports over exports of goods, as indicated by the decrease in the average monthly balances in our favor over the last two and one-fourth years. . . . Continued trend in the general direction now evident would soon produce gold exports even in the face of payments on account of Allied debts."

The importance to our foreign trade of restoring stability to exchange and of expediting the return of the depreciated currencies of Europe to the gold-standard par make it necessary to keep our present gold surplus free from credit complications, and available for export when the occasion demands. In anticipation of this loss of gold to our reserves, the government will have need for a normal output of newly produced gold.

Aside from the necessity of preventing a continued wastage of our gold-ore resources, the government should meet its obligation to adjust equitably its account with the gold-mining industry, especially when it has fixed the price of gold and has increased production costs by tariff protection afforded every other industry demanding governmental aid. To apply consistently the principle of protection, the government should remit a compensatory bounty upon newly produced gold.

MARKETING AND STATISTICS

Silver

The Pittman Act Purchases—Reserves of Silver in Europe —The Trade in China and India—The Marketing of Silver

By Felix Edgar Wormser
Assistant Editor

WHAT WILL HAPPEN to silver after the completion of the Pittman Act purchases? During 1922 this question could have been dismissed as involving too remote a contingency to require much consideration, but as 1923 is likely to witness the completion of the repurchases under the Pittman Act, the answer is engaging increased attention on the part of the miner of silver ore. From the behavior of the foreign silver market for the last eight months, during which the price of silver has gradually declined, it might be easy to conclude that this tendency will continue until the entire amount, 208,000,000 oz., of "dollar" silver has been purchased. The dismal conclusion would be reached that many silver mines must look forward to a discontinuance of operations. The fact that this gloomy view is held by many people is, of itself, ground for anticipating an entirely different trend of events. Silver is such a peculiar metal in its price fluctuations that these are as likely to move contrary to popular belief as with it.

It is true that many clouds on the silver horizon appear as disturbing factors. Nations are still disposed to discuss and carry into effect the substitution of nickel, aluminum, and base-metal alloys for silver in coinage. Judging from the disappearance of silver coins in Germany, and the debasement of subsidiary coinage in Great Britain, Holland, and other countries, one may reason that silver stocks or reserves are being exhausted; but an estimate made by an important London bullion broker indicates that about 200,000,000 oz. of silver is held in the monetary reserves of England, France, Germany, Austria, Hungary, Switzerland, Spain, and The Netherlands. Europe is evidently trying to hold on to silver as a nucleus for the basis of replenishment when the proper time comes. Other clouds over the silver market are the conditions of trade in India and China where business has improved but remains quiet. Both countries call for silver in settlement of favorable trade balances, so that a healthy export trade in India and China indicates a good demand for silver. An adverse influence in the silver market is the increased amount of metal being produced in the United States, Canada, and Mexico, all of which adds to the available world supply.

World production of silver in 1922 was larger than in 1921. The United States produced 55,500,000 oz., Mexico about 65,000,000 oz., and Canada, 17,000,000 oz. Silver supplies were increased by the quantities released from the partial and total demonetization of currencies in Europe, which would tend to bring the total world supplies, according to a bullion broker in London, close to the record production of 1911—226,000,000 oz. However, as American mine production has been absorbed by the U. S. Government, it cannot be considered in the same light as other production.

A particularly comforting line of reasoning has as its basis the hypothesis that silver closely follows or anticipates the world-commodity price level; and that, inasmuch as commodity prices are now about 50 per cent above the pre-war average, the value of silver also should stay well above its pre-war level. Although predictions as to the trend of prices of copper, lead, and zinc can sometimes be made with a fair assurance of accuracy, prophecy in regard to the course of silver and tin prices is exceedingly hazardous. It is to be noted that in both of these metals the Far East plays an important rôle.

Pittman Act Silver Repurchases in Troy Ounces

	Total Ounces
In 1920	29,907,360
1921	58,662,525
1922	62,181,015
Total	150,750,900

Total amount to be purchased, about 208,000,000 oz., leaving 57,249,100 oz. to be bought after 1922.

Purchases began May 13, 1920, at $1 per oz.

	Estimated Monthly Purchases, 1922
January	2,532,000
February	3,444,740
March	5,370,980
April	8,117,745
May	4,122,400
June	5,204,750
July	5,187,500
August	4,700,000
September	5,656,000
October	5,894,000
November	5,988,400
December	4,982,500
Total, 1922	62,181,015

The formation of a Silver Export Association is mooted in protest of London's control of the silver market, but such an organization could not do away with the present arrangement. The supremacy of London rests upon a substantial basis. The great Far Eastern banking and speculative interests make their headquarters there. Every facility is at the disposal of the trader for the quick dispatch of business through London banks. The British Government, of course, can exert a powerful influence on the purchase of bullion for India. The position of the London market has been strengthened since the war, and American bankers who have attempted to enter the Far Eastern field have met with stern competition. There are no interests in the United States, comparable with those abroad, which can give silver the broad speculative market demanded by the chief traders in the metal. Speculation is anathema to the majority of Americans, but it is encouraged in metal and commodity markets in Europe.

The silver outlook for 1923 is none too bright, especially for the latter part of the year. The market is still dependent on consumption in the Far East, and is subject to the whims of European governments that treat the metal as if they had little use for it. Nevertheless, Russia, Germany, and some other nations are anxious to return to a silver basis for their subsidiary currency, but are prevented from doing so by inability to maintain it in circulation. Stabilization of exchange would help. It behooves all silver producers to become familiar with the forces determining the world price of silver. By stimulating discussion, they can help to solve such problems as exchange stabilization and reparations settlement, both of which have an important bearing on the silver market.

MARKETING AND STATISTICS

Iron and Steel

Forecast and Actuality—Secondary Inflation in the Steel Industry —Fuel Situation—Probable Demand in 1923 General Outlook

BY B. E. V. LUTY

Special Correspondent, *Engineering and Mining Journal-Press*, 210 Bessemer Building, Pittsburgh, Pa.

THE JUSTIFICATION for the forecasts for 1922 in the steel industry might furnish encouragement for sanguine predictions for 1923. At the end of 1921 little improvement was expected in the demand for steel in the first half of 1922, and only the more optimistic predicted a revival in the autumn of the year. Yet the production of steel ingots in 1922 was about 34,000,000 gross tons, or between 75 and 80 per cent more than the production, of 19,224,084 tons, in 1921. After price declines in bars, shapes, plates, and wire products in the first two months of 1922, a strong upward movement occurred, representing an average advance in all finished steel of about $10 per net ton from the low point of early March.

Statistics show that 1922 was a good year for the industry; but the conditions were not really so satisfactory for producers or consumers as the figures would suggest. The production of steel in 1922 may have been in excess of the consumption, but the advance in price was partly due to increase in cost of production; the consumer pays more for steel, but the producer is not benefited proportionately.

SECONDARY INFLATION IN THE STEEL INDUSTRY

To some extent the improvement in conditions was at the expense of safety. The steel-making industry undertook to reduce the inflation caused by the war and by the excesses of 1920; but, as there has been a secondary inflation in trade generally, so there has been secondary inflation in the steel industry. Fortunately, this is at two points only: in the wage rates at mills and furnaces, and in the cost of fuel. The hourly rate for common labor, about 13c. in 1898 and 19c. in 1913, rose to 37c. during the war and to 46c. in 1920; it declined to 30c. in 1921, some mills and furnaces paying 25c. or less. On Sept. 1, 1922, it advanced to 36c. The rate seems high, but employers do not consider it so, relative to the cost of living. It cannot be claimed that it adds enough to the cost of making steel to handicap consumers.

The fuel situation is more serious. The wages paid for mining coal and for converting coal into coke are extremely high, but operations are below normal capacity, so overhead expense per ton is excessive. The coal when purchased is expensive; and the cloud of another strike on April 1, 1923, or a settlement with perpetuation of unsound conditions, hangs over the industry.

Bars, shapes, and plates were priced at 2c. per pound at the end of 1922, which is relatively high. On several occasions before the war they had sold at about 1c. per pound. Prices ruling for sheets, nails, pipe, and tin plate are considered moderately conservative. They represent a small margin of profit to producers; but the cost of fuel is high.

The opinion of the great majority of sellers and buyers at the beginning of 1923 was that steel prices are higher than they ought to be; but that the trade as a whole has so much momentum that there will be activity, with little if any fall in prices, for six months or so. Afterward, there will be a period of deflation and readjustment. These expectations may be erroneous, even as the 1921 depression proved shorter than was expected.

Monthly Average Price of Pig Iron, Pittsburgh

	Bessemer		Basic		No. 2 Foundry	
	1921	1922	1921	1922	1921	1922
January	33.96	21.55	31.96	20.15	33.88	21.34
February	28.96	21.46	26.96	19.71	30.25	20.88
March	28.16	21.35	26.46	19.96	27.85	20.83
April	26.96	22.50	24.46	21.26	26.77	22.70
May	26.21	26.36	23.84	26.87	25.56	25.96
June	24.96	26.96	22.66	26.96	24.38	25.96
July	22.84	26.77	20.76	26.33	22.36	25.97
August	21.96	30.44	20.29	27.18	21.53	30.88
September	21.96	35.27	21.21	34.70	22.82	36.75
October	21.96	35.27	20.96	31.77	22.96	33.40
November	21.96	33.52	20.96	29.37	22.74	30.55
December	21.96	29.87	20.65	26.34	21.96	27.69
Year	25.15	27.61	23.43	25.88	25.26	26.91

In dollars per long ton.

The condition in the steel-consuming industries at the beginning of 1923 is such that an abnormal demand may be expected. The production of steel in 1922 may have been in excess of the actual consumption. A difference between the two does not constitute an element of unsoundness; for, on account of the drastic liquidation of 1921, the United States at the beginning of 1922 had no normal stocks of steel and manufactured steel. Some restocking was natural, in order to conduct business smoothly and efficiently. It is possible, however, that in the winter of 1922-3 some buyers took steel chiefly because it could be had at prices that could not be duplicated in the open market, or was wanted as a reserve against the possibility of another coal strike. In the spring of 1923 the production of steel may not equal current consumption.

A large number of locomotives and freight cars were bought in 1922; and 1923 opened with many orders unfilled and other business pending, assuring full operation of car and locomotive shops for more than six months. The boom in garage and dwelling-house construction, which in the closing months of 1922 made drafts on pipe and wire mills beyond their ability to ship, promises to continue, although it may stop as suddenly as it began. The automobile trade is scheduled for heavy production for the early months of 1923. The industry produced more in 1922 than was predicted, and present indications must be taken seriously.

Late in 1922 the farmer bought heavily of steel products. The implement factories increased production, and the wire-fence makers were behind in filling orders.

There is an unfavorable outlook for the steel seller in the export trade and in the construction industry that involves skeleton steel work; but conditions may improve.

MARKETING AND STATISTICS

Tin

Price Range During 1922 Shows Decrease—Invisible Supplies of Tin—Statistics of Supplies, Deliveries, Stocks and Prices—Consumption of the Metal and General Industrial Conditions

By J. H. Lang
Tin Specialist, American Metal Co., 61 Broadway, New York

THE TIN MARKET opened in 1922 at £170 per long ton for spot Straits in London, declined rapidly to £142 12s. 6d., the low of the year, on Feb. 22, recovered gradually to the extent of about £20 in the next six or seven months, and advanced sharply to £188 15s. on Nov. 6, the high of the year. Then followed a reaction to £175 15s. and a recovery to £183 7s. 6d., at which the market closed.

The total price range in 1922 was £46, against £62 in 1921 (from £148 to £210), and £225 in 1920 (from £195 to £420). In New York the record for 1922, in cents per pound, is as follows: Open, Jan. 3, 32⅜c.; low, March 16, 28⅝c.; high and close Dec. 30, 39c. The price as expressed in cents was affected by fluctuation in the rate of exchange, which rose gradually from $4.21 at the beginning to $4.64 at the close of the year.

Supplies, Deliveries, Stocks and Prices

Statistics by Ricard & Freiwald, London. Figures represent long tons.

Supplies:	1922	1921	1920	1919	1913
Straits Settlements	62,903	36,107	45,431	51,045	62,467
Australia	1,420	1,175	3,000	2,600	3,300
Banka and Billiton	16,099	11,874	14,762	13,801	17,142
Standard	11 481	10,537	14,336	8,536	9,953
	91,903	59,693	77,529	75,982	92,862
Deliveries:					
United Kingdom	23,513	18,789	21,430	19,065	18,192
Continent	12,809	9,605	5,761	10,380	25,870
Total Europe	36,322	28,394	27,191	29,445	44,062
U. S. A.	57,360	25,678	53,219	33,004	45,448
Total	93,682	54,072	80,410	62,449	89,510
Visible supply Jan. 1	24,060	18,439	21,320	7,787	12,121
Visible supply Dec. 31	22,281	24,060	18,439	21,320	15,473
Decrease, visible supply	1,779	.....	2,881	.....	.....
Increase, visible supply	.....	5,621	.....	13,533	3,352
Opening price, per long ton, standard spot	£168½	206½	347½	235¼	229½
Closing price, per long ton, standard spot	£182¼	170½	205½	341¾	169¼

The statistics given above indicate a narrow limit variation, and show a gradual return to normal conditions, with healthy growth in England and the United States; the only sick spot is the Continent. The most interesting changes, however, must be sought outside statistics, in the so-called invisible supplies held back in the East, for instance, an estimate of which is given herewith.

Invisible Supplies of Tin

	End of 1921, Tons	End of 1922, Tons
Federated Malay States Government	10,000	10,000
Netherland East Indies	4,000	4,000
Straits Trading Co.	2,700	2,700
Billiton Co.	2,800	..
Bolivia	3,000	..
Hongkong	5,000	..
Afloat	2,500	2,100
	30,000	18,800
Add visible supply (Ricard)	24,060	22,281
Total stocks	54,060	41,081

At this rate of decrease, unsold stocks should be disposed of in 1923, when the market will breathe easier. Encouraging as this may seem, and warranting, as possibly it does, the recent advance in price, it is the occasion rather than the cause. The real and fundamental cause lies deeper in economic forces, the discussion of which is not within the province of this article, but the effect of which has been to advance the price of almost all commodities. Wheat, corn, cotton, leather, silk, wool, coffee, sugar, meat, cement, coal, lumber, iron, steel, copper, tin, lead, and zinc were all higher in price at the end of 1922 than at the beginning. The average of these advances is about 25 per cent; in tin it is about 20 per cent. A contributing if not a governing factor in bringing about this result is the business situation. The Department of Commerce has tabulated figures which show that business in general has been about 50 per cent above that of last year. As for the separate industries the steel trade reports an improvement of about 60 per cent; the motor-car industry, 50 per cent; building construction, 50 per cent; sugar, 50 per cent; paper, 20 per cent; textiles, 20 per cent; and non-ferrous metals, from 50 to 95 per cent.

Price of Tin, 1921-1922, New York and London

	New York				London	
	99%		Straits			
	1921	1922	1921	1922	1921	1922
January	31.470	31.480	36.000	32.100	190.464	163.065
February	28.534	29.835	32.142	30.767	166.250	149.850
March	27.296	28.426	28.806	29.171	156.024	143.152
April	28.990	29.810	30.404	30.605	163.905	149.840
May	31.431	30.149	32.500	30.971	177.411	150.163
June	28.514	30.707	29.423	31.497	167.506	152.512
July	26.755	31.025	27.655	31.733	164.530	156.149
August	25.662	32.134	26.301	32.380	155.318	160.006
September	26.280	32.075	26.680	32.395	156.750	160.065
October	27.278	33.935	27.655	34.600	156.380	170.563
November	28.592	35.911	28.935	36.734	158.898	179.341
December	32.106	36.480	32.486	37.695	169.738	178.697
Year	28.576	31.831	29.916	32.554	165.265	159.450

New York quotations, cents per lb. London, pounds sterling per long ton.

Tin will of necessity continue to keep step with economic conditions in general, however it may be distorted temporarily by speculative excesses. To diagnose correctly what will happen in the tin market during the next twelve months, it is only necessary to forecast accurately the trend of events in the United States. Europe will play its part, and it is probable that slow but sure improvement will continue there; but America, as usual, will play the dominant rôle. For the next three to six months, and possibly longer, there is no doubt of continued good business here. Factors to be reckoned with beyond that period are: (1) the disposition of Eastern stocks, (2) the balance between production and consumption, (3) the situation in Europe, and (4) conditions at home, none of which can now be predicated with certainty.

MARKETING AND STATISTICS

Yearly Average Prices of Principal Metals, 1895-1922

Prices in New York or St. Louis, cents per pound, except quicksilver (dollars per flask); silver and platinum (dollars per oz.). London quotations, pounds sterling per long ton.

	Copper		Lead		Tin		Zinc			Anti-mony	Quick-silver	Silver	Plat-inum
Year	Electrolytic New York	Standard London	New York	London	(*f*) New York	(*a*) London	New York	St. Louis	London	New York	New York	New York	New York
1895	10.76 (*b*)	.....	3.23	.....	14.05	63.333	3.63	.....	.....	7.560	39.58	65.250	.....
1896	10.88 (*b*)	.....	2.98	.....	13.29	59.496	3.94	.....	.....	6.650	37.00	67.060	.....
1897	11.29 (*b*)	.....	3.58	12.367	13.67	61.400	4.12	.....	.....	6.750	38.50	59.790	.....
1898	12.03 (*b*)	.....	3.78	12.983	15.70	71.204	4.57	.....	.....	8.690	40.70	58.260	.....
1899	16.67	.....	4.47	14.933	25.12	122.429	5.75	.....	.....	9.430	43.63	59.580	15.22
1900	16.19	.....	4.37	16.987	29.90	133.575	4.39	.....	.....	9.500	51.00	61.330	18.09
1901	16.11	.....	4.33	12.521	26.74	118.633	4.07	.....	.....	8.250	47.00	58.950	20.00
1902	11.626	52.460	4.069	11.262	26.79	120.720	4.84	.....	.....	6.120	48.03	52.160	19.00
1903	13.235	57.970	4.237	11.579	28.09	127.320	5.40	5.191	.....	6.000	41.32	53.570	18.91
1904	12.823	58.884	4.309	11.983	27.99	126.733	5.100	4.931	.....	6.371	41.00	57.221	19.50
1905	15.590	69.465	4.707	13.719	31.358	143.083	5.882	5.730	25.433	10.250	38.50	60.352	20.34
1906	19.278	87.282	5.657	17.370	39.819	180.646	6.198	6.048	27.020	21.730	40.90	66.791	28.04
1907	20.004	87.007	5.325	19.034	38.166	172.638	5.962	5.812	23.771	14.840	41.50	65.327	30.98
1908	13.208	59.902	4.200	13.439	29.465	133.124	4.726	4.578	20.163	8.004	44.84	52.864	16.32
1909	12.982	58.732	4.273	13.042	29.725	134.774	5.503	5.352	22.185	7.466	46.30	51.502	24.87
1910	12.738	57.054	4.446	12.920	34.123	155.308	5.520	5.370	23.050	7.386	47.06	53.486	32.70
1911	12.376	55.973	4.420	13.970	42.281	192.353	5.758	5.608	25.281	7.540	46.54	53.340	43.12
1912	16.341	72.942	4.471	17.929	46.096	209.420	6.943	6.799	26.421	7.760	42.46	60.835	45.55
1913	15.269	68.335	4.370	18.743	44.252	201.679	5.648	5.504	22.746	7.520	39.54	59.791	44.88
1914	13.602	61.524(*e*)	3.862	19.076(*e*)	34.301	156.564(*e*)	5.213	5.061	22.544(*e*)	8.763	48.31	54.811	45.14
1915	17.275	72.532	4.673	22.917	38.590	163.960	13.230	13.054	67.533	30.280	87.01	49.684	47.13
1916	27.202	116.059	6.858	31.359	43.480	182.096	12.804	12.634	72.071	25.370	125.49	65.661	83.40
1917	27.180	124.892	8.787	30.500	61.802	237.563	8.901	8.730	52.413	20.690	106.30	81.417	102.82
1918	24.628(*d*)	115.530	7.413	30.100	(*e*)	330.138	8.159	7.890	54.180	12.581	123.47	96.772	105.95
1919	18.691	90.796	5.759	28.590	63.328	257.601	7.338	6.988	42.879	8.190	92.15	111.122	114.61
1920	17.456	97.480	7.957	37.832	48.273	295.866	(*e*)	7.671	44.372	8.485	81.12	100.900	110.90
1921	12.502	69.356	4.545	22.752	28.576	165.265	(*e*)	4.655	25.845	4.957	45.46	62.654	75.03
1922	13.382	62.123	5.734	24.097	31.831	159.450	(*e*)	5.716	30.003	5.471	58.946	67.521	97.618

(*a*) Prices of tin, London, from 1895 to 1914 from statistical report of Metallgesellschaft, Frankfurt-am-Main. (*b*) Prices 1895 to 1898 are for Lake Copper. (*c*) Averages for nine months, no quotations being made during August, September, and October. (*d*) Average of eleven months, no quotations being made in December. (*e*) No average computed. (*f*) 99 per cent tin.

Preliminary Estimate of 1922 Metal Production in the United States

U. S. Geological Survey

	Gold	Silver, Oz.	Copper, Lb.	Lead, Lb.	Zinc, Lb.
Alaska	$7,720,000	730,000	70,000,000	.....	.....
Arizona	3,618,000	4,760,000	418,000,000	14,080,000	.....
California	14,845,000	3,181,200	22,660,500	6,260,800	3,615,900
Colorado	6,500,000	6,000,000	3,600,000	22,000,000	24,000,000
Idaho	490,000	5,998,000	3,946,000	195,300,000	4,400,000
Montana	1,664,000	12,500,000	165,100,000	29,775,000	114,000,000
Nevada	3,147,000	8,198,000	19,892,000	9,107,000	3,200,000
New Mexico	374,000	700,000	31,000,000	2,600,000	4,500,000
Oregon	501,870	47,000	1,089,000	.....	.....
South Dakota	6,636,000	120,000	.....	.....	.....
Texas	.....	600,000	.....	.....	.....
Utah	2,201,500	16,800,000	95,500,000	134,000,000	5,290,000
Washington	181,700	192,000	335,000	1,500,000	.....

Zinc Statistics

Smelter Production in the United States, 1917-1922

In Tons of 2,000 Lb.

	1917	1918	1919	1920	1921	1922
Arkansas	25,701	26,750	31,396	29,966	14,917	16,146
Colorado	7,735	3,897	2,779	1,682	1,200	.....
Illinois	176,071	141,808	118,631	109,483	52,183	77,929
Missouri-Kansas	86,505	31,834	43,347	25,131	31,784	23,966
Oklahoma	204,587	143,371	119,454	97,690	36,644	74,568
Electrolytic	27,245	38,885	25,962	57,441	11,553	55,349
East and others	154,567	138,805	130,115	158,379	67,333	125,720
Totals	682,411	525,350	471,684	479,772	215,614	373,678

Production for 1920, 1921, and 1922 through the courtesy of the American Zinc Institute.

Monthly Production, Stocks and Retort Data

1922	On Hand First of Month	Produced During Month	Shipped During Month	On Hand End of Month	1922 Retorts Average No Oper. End of Month
January	66,608	23,706	24,636	65,678	44,457
February	65,678	22,513	24,067	64,124	43,357
March	64,124	26,532	30,394	60,262	45,373
April	60,262	25,506	34,040	51,728	42,773
May	51,728	27,419	38,738	40,409	48,765
June	40,409	28,547	39,380	29,576	52,677
July	29,576	31,917	32,875	28,618	54,909
August	28,618	31,423	38,412	21,629	57,193
September	21,629	33,134	35,957	18,806	65,936
October	18,806	39,940	40,703	18,043	72, '6
November	18,043	40,200	38,746	19,497	75,064
December	19,497	42,841	44,086	18,252	80,863
Tons	.....	373,678	422,034		

Total retorts, Dec. 31, 1922, 143,528; retorts available, 123,014.

Lead Statistics

Production of Lead Refineries 1917-1922 (a)

In Tons of 2,000 Lb.

Domestic	1917	1918	1919	1920	1921	1922
Desilverized	319,015	284,733	226,085	236,912	202,649	210,039
Antimonial	16,265	18,658	14,864	8,992	5,419	6,265
S. E. Missouri	205,861	189,207	158,182	206,836	142,804	203,327
S. W. Missouri	40,575	63,635	55,790	29,004	56,155	63,666
Totals	581,716	556,233	454,921	471,744	406,896	483,297
Foreign						
Desilverized	50,962	98,596	61,380	51,700	47,697	66,781
Antimonial	2,991	2,083	1,547	2,197	2,361	1,126
Totals	53,953	100,679	62,927	53,897	50,058	67,907
Grand totals	635,669	656,912	517,848	525,641	456,954	551,204

(*a*) Including lead derived from scrap and junk by primary smelters.

Chilean Nitrate Statistics

Yearly and Monthly Averages, Metric Tons

	Production	Exports	Consumption	Visible Stocks Chile	Visible Stocks Abroad	Visible Stocks Total
1911–13 average	219,000	214,000	200,000	481,000	1,204,000	1,685,000
1920, average	210,500	233,000	136,000	1,305,000	.....	.....
1921, Jan.–June	142,000	131,000	130,000	1,360,000	860,000	2,120,000
1921, July-Dec.	77,500	55,600	51,500	1,491,000	918,000	2,409,000
1922, Jan.	69,500	66,700	89,000	1,490,000	910,000	2,400,000
Feb.	62,200	32,200	173,000	1,520,000	785,000	2,305,000
Mar.	71,960	24,200	288,000	1,570,000	544,000	2,114,000
Apr.	72,100	106,500	156,000	1,530,000	425,000	1,955,000
May	74,900	20,700	176,000	1,580,000	314,000	1,894,000
June	72,900	32,500	.....	1,625,000	258,000	1,883,000
July	82,600	106,600	.....	1,576,000	276,000	1,852,000
Aug.	96,800	166,200	.....	1,531,000	305,000	1,836,000
Sept.	101,500	115,600	.....	1,516,000	334,000	1,850,000
Oct.	115,400	208,000	.....	1,423,000	380,000	1,803,000
1922, average	82,300	87,900	150,000			

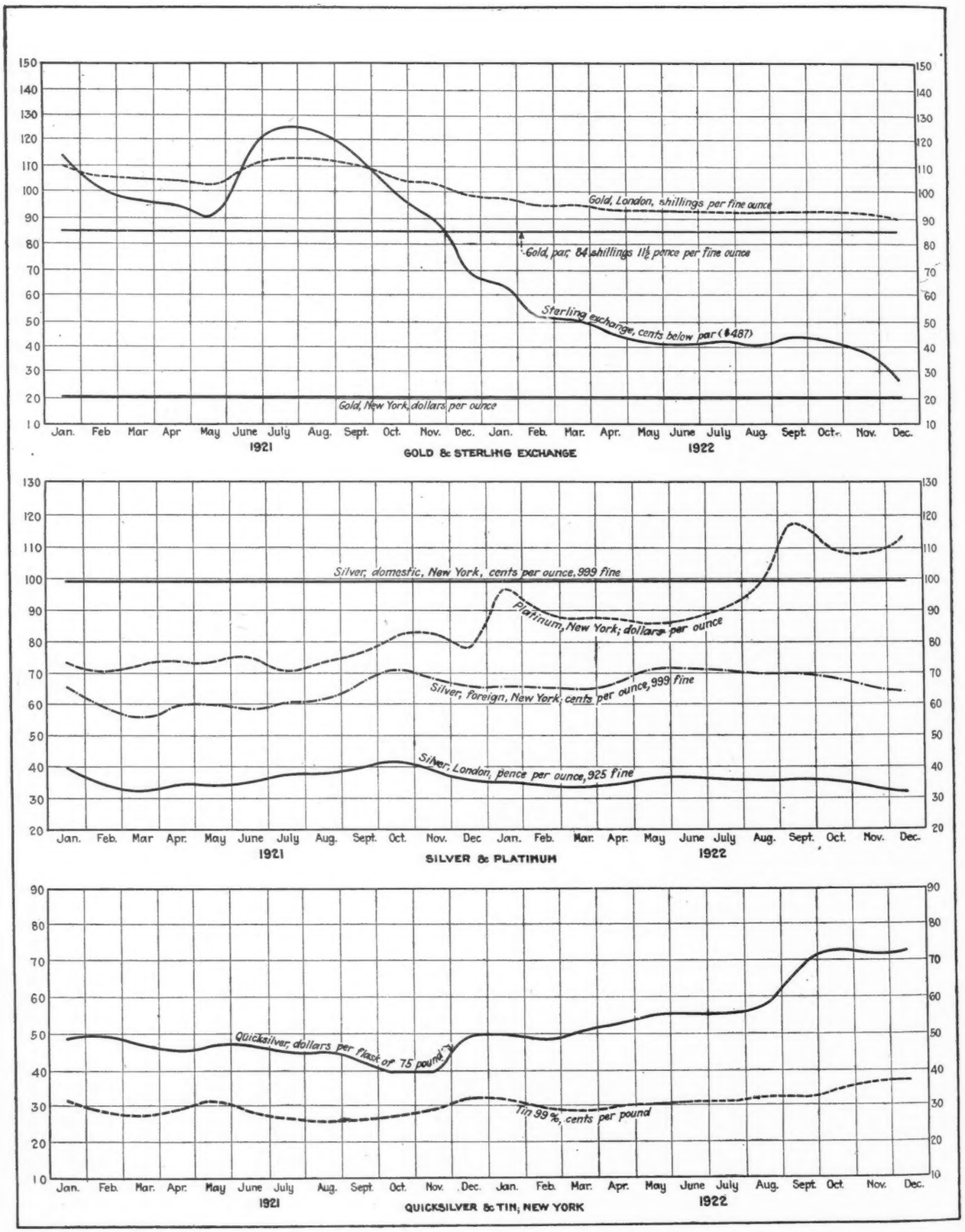
Destination of Exports, Metric Tons

	Europe	U. S. A.	Elsewhere	Total
1911–13, average	160,000	45,300	8,700	214,000
1920, average	109,000	107,500	16,000	232,500
1921, Jan.–June	81,600	45,000	4,000	130,600
1921, July-Dec.	33,400	12,300	8,900	54,600
1922, Jan-Sept.	31,100	34,500	9,100	74,600

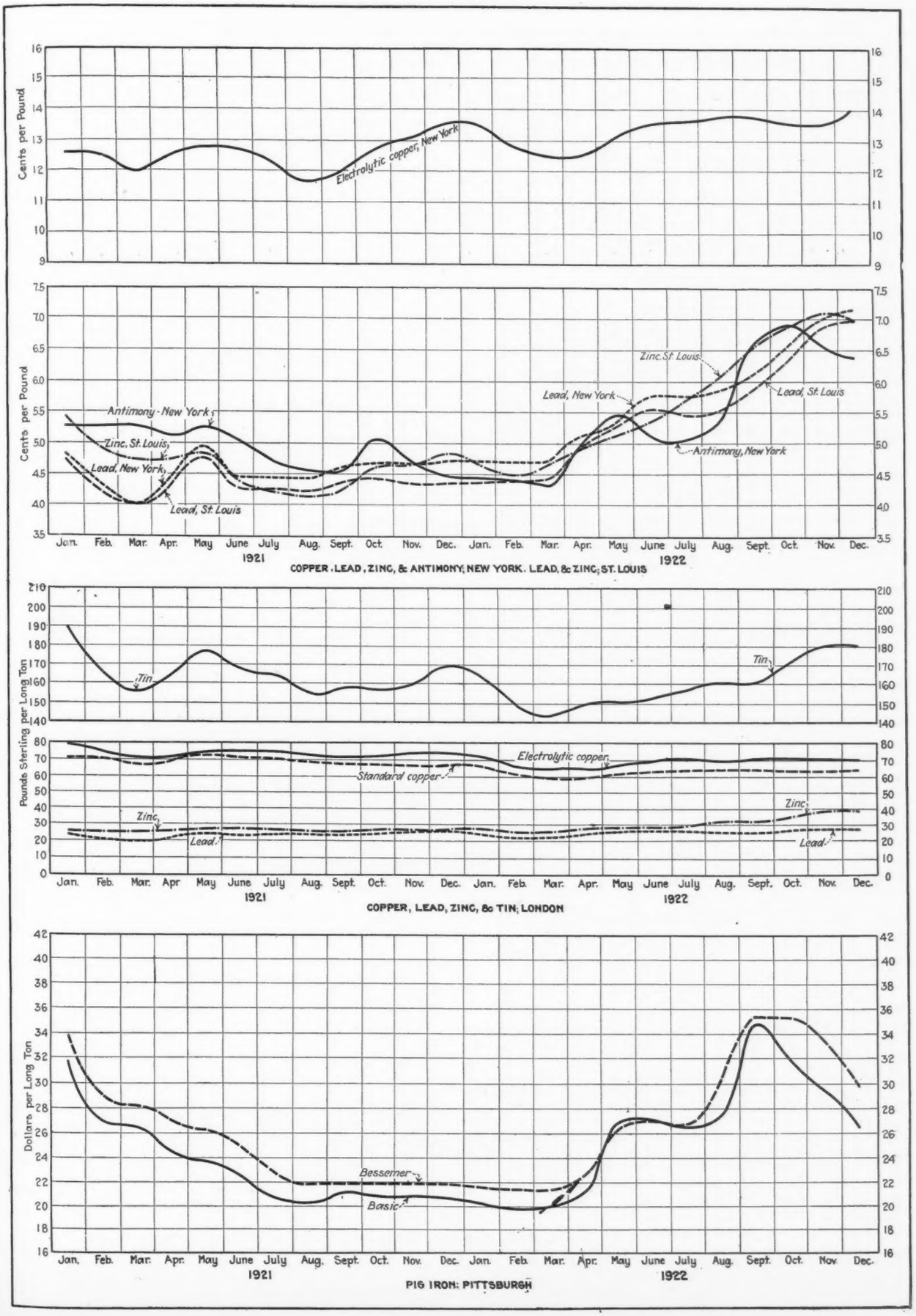
Price, per Metric Ton, f.a.s. Chilean Ports

	1913	1919	1920	1921	1922
Jan.	£6.98	£10.95	£15.25	£18.75	£11.95
Feb.	7.05	10.95	16.30	18.75	11.95
March	6.85	10.95	17.15	18.75	11.95
April	6.65	10.95	13.23	18.50	11.95
May	6.50	11.40	14.40	18.50	11.70
June	6.40	10.70	15.10	18.50	11.15
July	6.40	10.80	16.80	18.50	9.25
Aug.	6.70	10.95	17.25	18.50	9.50
Sept.	6.70	10.95	17.40	18.50	10.00
Oct.	6.65	10.25	17.65	11.40	.....
Nov.	6.60	10.15	17.90	11.95	.....
Dec.	6.75	12.05	18.13	11.95	.....

Metal Price Charts


Gold, London, shillings per fine ounce
Gold, par, 84 shillings 11½ pence per fine ounce
Sterling exchange, cents below par ($4.87)
Gold, New York, dollars per ounce
Jan. Feb Mar Apr May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
GOLD & STERLING EXCHANGE
Silver, domestic, New York, cents per ounce, 999 fine
Platinum, New York; dollars per ounce
Silver, foreign, New York, cents per ounce, 999 fine
Silver, London, pence per ounce, 925 fine
Jan. Feb. Mar Apr. May June July Aug. Sept. Oct. Nov. Dec Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
SILVER & PLATINUM
Quicksilver, dollars per flask of 75 pounds
Tin 99%, cents per pound
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
QUICKSILVER & TIN, NEW YORK

MARKETING AND STATISTICS


Cents per Pound
Electrolytic copper, New York
Antimony-New York
Zinc, St. Louis
Lead, New York
Lead, St. Louis
Zinc, St. Louis
Lead, New York
Lead, St. Louis
Antimony, New York
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
COPPER, LEAD, ZINC, & ANTIMONY; NEW YORK. LEAD, & ZINC; ST. LOUIS
Pounds Sterling per Long Ton
Tin
Tin
Electrolytic copper
Standard copper
Zinc
Lead
Zinc
Lead
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
COPPER, LEAD, ZINC, & TIN; LONDON
Dollars per Long Ton
Bessemer
Basic
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
1922
PIG IRON: PITTSBURGH

DIRECTORY

Professional Organizations

The following list contains the more important national professional organizations in the non-ferrous mining industries of the United States and the British Empire, with the postal address of the secretary:

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York.
Mining and Metallurgical Society of America, 115 Broadway, New York.
Society of Economic Geologists, 42 Broadway, New York.
Geological Society of America, Museum of Natural History, Columbus Ave. and 77th St., New York.
Geological Society of Washington, U. S. Geological Survey, Washington, D. C.
American Electrochemical Society, Columbia University, New York.
American Chemical Society, 1709 G St., N. W., Washington, D. C.
Institution of Mining and Metallurgy, 225 City Road, London E.C.1, England.
Society of Chemical Industry, Central House, Finsbury Square, London, E.C.2, England; Pratt Institute, Brooklyn, New York.
Geological Society of London, Burlington House, London, W., England.
Canadian Institute of Mining and Metallurgy, Drummond Building, Montreal, Quebec, Canada.
Australasian Institute of Mining and Metallurgy, 48 Queen St., Melbourne, Victoria, Australia.
Chemical, Metallurgical and Mining Society of South Africa, 100 Fox St., Johannesburg, Transvaal, South Africa.

Mining and Allied Educational Institutions

The following is a list of the principal educational institutions in the United States, Canada, and Mexico, in which mining engineering subjects are taught:

UNITED STATES

Alabama
Mine Experiment Station, University of Alabama, University, Ala.; Dr. H. D. Pallister.

Alaska
Alaska Agricultural College and School of Mines, Fairbanks, Alaska; Charles E. Bunnell, President.

Arizona
College of Mines and Engineering, Tucson, Ariz.; G. M. Butler, Director.

Arkansas
Department of Geology, University of Arkansas, Fayetteville, Ark.; Gilbert H. Cady, Head.

California
College of Mines, University of California, Berkeley, Calif.; Frank H. Probert, Dean.
Department of Mining Engineering, Leland Stanford, Jr., University, Palo Alto, Calif.; Theodore J. Hoover, Dean.

Colorado
Colorado School of Mines, Golden, Colo.; Victor C. Alderson, President.

Connecticut
Department of Mines and Metallurgy, Sheffield Scientific School, Yale University, New Haven, Conn.; Prof. B. Britton Gottsberger, Head.

Idaho
Department of Mines and Metallurgy, University of Idaho, Moscow, Idaho; Francis A. Thomson, Dean.

Illinois
Mining Engineering Department, University of Illinois, Urbana, Ill.; Prof. H. H. Stoek, Head.

Iowa
Mining Engineering Department, Iowa State College, Ames, Iowa; Prof. A. K. Friedrich, Head.

Kansas
Department of Mining Engineering, University of Kansas, Lawrence, Kan.; Prof. C. M. Young, Head.

Kentucky
Department of Mines and Metallurgy, University of Kentucky, Lexington, Ky.; C. J. Norwood, Head.

Massachusetts
Department of Mining, Metallurgy and Geology, Massachusetts Institute of Technology, Cambridge, Mass.; Prof. Waldemar Lindgren, Head.

Michigan
Michigan College of Mines, Houghton, Mich.; F. W. McNair President.

Minnesota
School of Mines, University of Minnesota, Minneapolis, Minn.; W. R. Appleby, Dean.

Missouri
Missouri School of Mines and Metallurgy, Rolla, Mo.; Dr. Charles. H. Fulton, Director.

Montana
Department of Geology, University of Montana, Missoula, Mont.; Prof. J. P. Rowe, Head.
Montana State School of Mines, Butte, Mont.; G. W. Craven, President.

Nevada
Mackay School of Mines, University of Nevada, Reno, Nev.; F. C. Lincoln, Director.
Virginia City School of Mines, Virginia City, Nev.; James D. McPherson, Principal.

New Mexico
New Mexico School of Mines, Socorro, N. M.; E. H. Wells, President.

New York
School of Mines, Columbia University, New York, N. Y.; Prof. A. L. Walker, Head.

North Dakota
School of Mines, University Station, Grand Forks, N. D.; Dr. E. J. Babcock, Dean.

Ohio
Case School of Applied Science, Cleveland, Ohio; Charles S. Howe, President.
Department of Mine Engineering, Ohio State University, Columbus, Ohio; H. E. Nold, Professor.

Oklahoma
College of Engineering, University of Oklahoma, Norman, Okla.; J. H. Felgar, Dean.
Oklahoma School of Mines and Metallurgy, Wilberton, Okla.; Mead S. Johnson, President.

Oregon
Oregon School of Mines, Corvallis, Ore.

Pennsylvania
Department of Mining and Metallurgy, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.; Prof. Fred Crabtree, Head.
Department of Mining Engineering, Lehigh University, Bethlehem, Pa.; Prof. Howard Eckfeldt, Head.
Department of Mining Engineering, Lafayette College, Easton, Pa.; W. B. Plank, Head.
School of Mines, University of Pittsburgh, Pa.; H. B. Meller, Dean.
School of Mines, Pennsylvania State College, State College, Pa.; E. A. Holbrook, Dean.

South Dakota
South Dakota State School of Mines, University of South Dakota, Rapid City, S. D.; C. C. O'Hara, Principal.

Texas
College of Mines and Metallurgy, University of Texas; name of principal unobtainable.

Utah
Schools of Mines and Engineering, University of Utah, Salt Lake City, Utah; Dr. Joseph H. Merrill, Director.

Washington
College of Mines, University of Washington, Seattle, Wash.; Milnor Roberts, Dean.
School of Mines and Geology, State College of Washington, Pullman, Wash.; L. O. Howard, Dean.

West Virginia
Department of Mining Engineering, West Virginia University, Morgantown, W. Va.; Prof. A. C. Callen, Head.

DIRECTORY

Wisconsin
Wisconsin Mining School, Platteville, Wis.; H. B. Morrow, Director.

Virginia
Department of Mining Engineering, Virginia Polytechnic Institute, Blacksburg, Va.; Prof. O. C. Burkhart, Head.

CANADA
University of Toronto, Queen's Park, Toronto, Ont.
Queen's University, Kingston, Ont.
McGill University, Montreal, Que.
University of Manitoba, Winnipeg, Manitoba.
University of Alberta, Edmonton, Alberta.
University of British Columbia, Vancouver, B. C.

MEXICO
Escuelas de Ingenieros, Mérida, Yucatan.
Escuelas de Ingenieros, Morélia, Michoacan.
Escuela Nacional de Maestros, Zacatecas, Zacatecas.
Colegio de Estato, Guanajuato, Guanajuato.
Ingenieros Agrónimos, Leon, Guanajuato.
Instituto Juarez, Villahermosa, Tabasco.
Universidad Nacional de México, Mexico, D. F.
Instituto Geológico, Mexico, D. F.

U. S. Bureau of Mines

The personnel of the chief administrative officials of the U. S. Bureau of Mines is as follows:

Washington, D. C.
Director, H. Foster Bain.
Assistant Director, A. W. Ambrose.
Assistant to Director, F. J. Bailey.
Chief Clerk, Harrison E. Meyer.
Chief Mining Engineer, Chief of Division of Mining, George S. Rice.
Chief Mechanical Engineer, Chief of Division of Fuels, Ozni P. Hood.
Chief Metallurgist and Supervisor of Mining Experiment Stations, Dorsey A. Lyon.
Chief Chemist, Chief of Division of Mineral Technology, Richard B. Moore.
Chief Petroleum Technologist, Chief of Division of Petroleum and Natural Gas, F. B. Tough.
Chief of Division of War Minerals Supply, Harry S. Mulliken.
Chief Explosives Chemist, C. E. Munroe.
Chief Engineer, U. S. Government Fuel Yards, George S. Pope.
Chief, Division of Information Service, Thomas T. Read.
Chief Surgeon, Chief of Medical Division, R. R. Sayers.

Pittsburgh, Pa.
Chief Engineer, Division of Mine Safety Service, D. J. Parker.
Chief Coal Mining Engineer, James W. Paul.
Fuel Engineer, Fuel Testing Section, John Blizzard.
Explosives Engineer, Explosives Experiment Station, Spencer P. Howell.
Petroleum Chemist, in charge Chemical Laboratory, N. A. C. Smith.

U. S. Geological Survey

The personnel of the chief administrative officials of the U. S. Geological Survey, Washington, D. C., is as follows:

Acting Director, Philip S. Smith.
Chief Clerk, H. C. Rizer.
Geologic Branch, Walter C. Mendenhall.
Division of Geology, Sidney Paige.
Division of Mineral Resources, G. F. Loughlin.
Division of Chemical and Physical Research, George Steiger.
Alaskan Mineral Resources Branch, Alfred H. Brooks.
Topographic Branch, C. H. Birdseye.
Atlantic Division, Frank Sutton.
Central Division, W. H. Herron.
Rocky Mountain Division, Glenn S. Smith.
Pacific Division, T. G. Gerdine.
Section of Inspection and Editing of Topographic Maps, W. M. Beaman.
Section of Cartography, A. F. Hassan.
Water-Resources Branch, N. C. Grover.
Division of Surface Water, John C. Hoyt.
Division of Ground Water, O. E. Meinzer.
Division of Quality of Water, W. D. Collins.
Division of Power Resources, A. H. Horton.
Division of Enlarged and Stock-Raising Homesteads, N. C. Grover.
Land-Classification Branch, Herman Stabler.
Division of Mineral Classification, J. D. Northrop.
Division of Hydrographic Classification, W. G. Hoyt.
Publication Branch,
Section of Texts, G. M. Wood.
Section of Illustrations, M. Solem.
Division of Distribution, R. C. Shelse.
Division of Engraving and Printing, S. J. Kubel.
Administrative Branch,
Executive Division, Guy E. Mitchell.
Library, J. L. V. McCord.
Division of Accounts, J. J. Madigan.

State Geologists and Engineers

The following is a list of state officials directly or indirectly connected with the mining industries, with whom the U. S. Geological Survey is in contact:

Alabama
Prof. Eugene A. Smith, State Geologist, University of Alabama, University, Ala.

Arizona
Dr. G. M. Butler, Director; Carl Lausen, Geologist; University of Arizona, Tuscon, Ariz.

Arkansas
Dr. Gilbert H. Cady, State Geologist, University of Arkansas, Fayetteville, Ark.
J. G. Ferguson, Commissioner of Mines, Manufactures, and Agriculture, Little Rock, Ark.

California
F. McN. Hamilton, State Mineralogist, San Francisco.

Colorado
Prof. Russell D. George, State Geologist, University of Colorado, Boulder, Colo.

Connecticut
Prof. Henry H. Robinson, Superintendent, State Geological and Natural History Survey, Yale University, New Haven, Conn.

Florida
Herman Gunter, State Geologist, Florida State Geological Survey, State Geological Survey, Tallahassee, Fla.

Georgia
Prof. S. W. McCallie, State Geologist, Geological Survey of Georgia, Atlanta, Ga.

Idaho
Francis A. Thomson, Secretary, Bureau of Mines and Geology, and Dean, School of Mines; Dr. F. B. Laney, Department of Geology, University of Idaho, Moscow, Idaho.

Illinois
Frank W. DeWolf, Chief, State Geological Survey Division, Department of Registration and Education, Urbana, Ill.

Indiana
Prof. W. N. Logan, State Geologist, Department of Geology and Natural Resources, Indianapolis, Ind.

Iowa
Prof. George F. Kay, Director, Iowa Geological Survey, Iowa City, Iowa.

Kansas
Dr. Raymond C. Moore, State Geologist, University of Kansas, Lawrence, Kan.

Kentucky
Dr. W. R. Jilson, State Geologist and Director, Kentucky Geological Survey, Frankfort, Ky.

Louisiana
Louisiana Soil and Geological Survey, Louisiana State University, Baton Rouge, La.

Maryland
Dr. Edward B. Mathews, State Geologist, Maryland Geological Survey, Johns Hopkins University, Baltimore, Md.

Michigan
Richard A. Smith, Chief of the Michigan Geological and Biological Survey Division, Department of Conservation, Lansing, Mich.

Minnesota
Prof. W. H. Emmons, Director, Minnesota Geological Survey, University of Minnesota, Minneapolis, Minn.

DIRECTORY

Mississippi
Dr. E. N. Lowe, Director, Mississippi Geological Survey, Jackson, Miss.

Missouri
H. A. Buehler, State Geologist and Director, Bureau of Geology and Mines, Rolla, Mo.

Montana
Dr. J. P. Rowe, State Geologist, University of Montana, Missoula, Mont.
Dr. C. H. Clapp, Director, State Bureau of Mines and Metallurgy, Butte, Mont.

Nebraska
Prof. E. H. Barbour, State Geologist, University of Nebraska, Lincoln, Neb.

Nevada
Andy J. Stinson, Inspector of Mines, Carson City, Nev.
Prof. Francis Church Lincoln, Director, Mackay School of Mines, University of Nevada, Reno, Nev.

New Jersey
Dr. H. B. Kummel, Director and State Geologist, Department of Conservation and Development, Trenton, N. J.

New Mexico
Prof. R. W. Ellis, State Geologist, University of New Mexico, Albuquerque, N. M.

New York
Dr. John M. Clarke, State Geologist, University of the State of New York, Albany, N. Y.

North Carolina
Colonel Joseph Hyde Pratt, State Geologist, North Carolina Geological and Economic Survey, Chapel Hill, N. C.

North Dakota
Dr. A. G. Leonard, State Geologist, State Geological Survey, University of North Dakota, University, N. D.
Prof. Howard E. Simpson, State Water Geologist, University N. D.

Ohio
Prof. J. A. Bownocker, State Geologist, Geological Survey of Ohio, Columbus, Ohio.
Prof. C. E. Sherman, Inspector, Ohio Co-operative Topographic Survey, Columbus, Ohio.

Oklahoma
C. W. Shannon, Director, Oklahoma Geological Survey, Norman, Okla.

Oregon
Henry M. Parks, Director, Oregon Bureau of Mines and Geology, Portland, Ore.

Pennsylvania
Dr. George H. Ashley, State Geologist, Topographic and Geological Survey, Harrisburg, Pa.

South Dakota
Dr. Freeman Ward, State Geologist, State Geological and Natural History Survey, Vermilion, S. D.

Tennessee
Wilbur A. Nelson, State Geologist, Tennessee State Geological Survey, Nashville, Tenn.

Texas
Dr. J. A. Udden, Director, Bureau of Economic Geology and Technology, Austin, Tex.

Utah
Prof. William Peterson, State Geologist, Agricultural College of Utah, Logan, Utah.

Vermont
Dr. George H. Perkins, State Geologist, University of Vermont, Burlington, Vt.

Virginia
Dr. Thomas L. Watson, Director and State Geologist, Virginia Geological Survey, Charlottesville, Va.

Washington
Prof. Solon Shedd, Supervisor of Geology, Department of Conservation and Development, Pullman, Wash.

West Virginia
Dr. I. C. White, State Geologist, West Virginia Geological Survey, Morgantown, W. Va.

Wisconsin
Dr. W. O. Hotchkiss, Director, Geological and Natural History Survey, Madison, Wis.

Wyoming
G. B. Morgan, State Geologist, Geological Survey of Wyoming, Cheyenne, Wyo.

Trade Associations

The following is a list of trade associations connected, with United States mining industries:

General
American Mining Congress, Washington, D. C.
Association of Arizona Mining Men, Phoenix, Ariz.
California Metal and Mineral Producers' Association, San Francisco.
Chamber of Commerce and Mines, Douglas, Ariz.
Chamber of Mines and Oil, Los Angeles, Calif.
Idaho Mining Association, Mackay, Idaho.
Montana Mining Men's Association, Helena, Mont.
National Metal Trades Association, Chicago, Ill.
Nevada Mine Operators' Association, Reno, Nev.
Northwest Mining Association, Spokane, Wash.

Copper
Copper Export Association, Copper and Brass Research Association, 25 Broadway, New York.

Crushed Stone
California Rock, Sand, and Gravel Producers' Association, San Francisco.
Indiana Crushed Stone Association, 802 Hume-Mansor Building, Indianapolis, Ind.
Minnesota Mineral Aggregate Association, Minneapolis, Minn.
National Crushed Stone Association, 405 Hartman Building, Columbus, Ohio.
Nebraska Mineral Aggregate Association, 313 McCague Building, Omaha, Neb.
Southeastern Crushed Stone Association, Central Building, Atlanta, Ga.
Tennessee Sand Gravel, and Stone Association, Nashville, Tenn.
Texas Sand, Gravel and Crushed Stone Association, Dallas, Tex.
Tri-State Road Materials Association, Memphis, Tenn.
Wisconsin Mineral Aggregate Association, 1018 Railway Exchange Building, Milwaukee, Wis.

Gold
American Gold and Silver Institute, Washington, D. C.

Granite
Granite Paving-Block Manufacturers' Association of the United States, 13 Park Row, New York.
International Monumental Granite Producers' Association, Boston, Mass.

Graphite
Plumbago-Graphite Association, 17 State St., New York.

Gypsum
Gypsum Industries Association, 111 W. Washington St., Chicago.

Iron and Steel
American Iron and Steel Institute, 40 Rector St., New York.
American Pig Iron Association, Pittsburgh, Pa.
Association of American Steel Manufacturers, Pittsburgh, Pa.
Lake Superior Iron Ore Association, Cleveland, Ohio.

Kaolin
Southern Kaolin Miners' Association, Macon, Ga.

Lead
American Institute of Lead Manufacturers, 90 West St., New York.

Limestone, Lime
Indiana Limestone Quarrymen's Association, Bedford, Ind.
National Agricultural Limestone Association, Columbus, Ohio.
National Lime Association, Washington, D. C.
Sand, Lime, Brick Association, Saginaw, Mich.
Southern Agricultural Limestone Association, Carterville, Ga.

Magnesia
Magnesia Association of America, Philadelphia, Pa.

Magnesite
Western Magnesite Association, San Francisco.

Petroleum
American Petroleum Institute, 19 West 44th St., New York.

Phosphate Rock
Phosphate Export Association, 2 Rector St., New York

Portland Cement
Portland Cement Association, 347 Madison Ave., New York.

Potash
U. S. Potash Producers' Association, 800 Southern Building, Washington, D. C.

Refractories
Refractories Manufacturers' Association, 840 Oliver Building, Pittsburgh, Pa.

Slate
National Slate Association, Philadelphia, Pa.
Pennsylvania Slate Manufacturers' Association, 239 Market St., Bangor, Pa.

Talc
Talc and Soapstone Producers' Association, 1448 Girard St., N. W., Washington, D. C.

Zinc
American Zinc Institute, 27 Cedar St., New York.

PLANT AND EQUIPMENT

New Construction

ARIZONA

Ajo—New Cornelia begins construction of 5,000-ton concentrating plant and enlargement of power plant; mill installed by Black Bess company in the Gunsight district.

Benson—Plant of Apache Powder Co. completed.

Bisbee—Phelps Dodge Corporation completes construction of 4,000-ton concentrating plant, 6,500-hp. Diesel-engine power plant, and concreting of Dallas shaft; Calumet & Arizona completes concreting of the Junction shaft.

Clarkdale—Crushing plant being installed by the United Verde; Cottrell smoke-treatment plant completed at the United Verde smelter.

Douglas—Crushing equipment added at the Copper Queen smelter.

Globe—Milling equipment installed at the asbestos mines.

Jerome—Hoisting and pumping equipment installed at the Verde Central mine.

Kingman—Mill and flotation plant completed at the McCracken mine; 100-ton mill completed by the Gold Chain company, and 250-ton mill completed at the Signal mine.

Morenci—Stargo Mining Co. erects 100-ton mill and cyanide plant.

Oatman—Tom Reed Mining Co. installs sampling mill.

Superior—Magma Copper Co. constructs 34-mile railroad.

Tombstone—Steam plant and hoist erected at the Solstice mine.

CALIFORNIA

Allegheny—Mill erected by Sixteen to One Mining Co.

Big Bear—Surface equipment erected at Surcease mine of Gruss Mining Co.

Bullard's Bar—Construction of dams and appurtenances by Yuba Development Co.

Darwin—Darwin Silver Co. completes mill.

Engels—Beardsley Mining Co. erects mill and flotation plant.

Grass Valley—Idaho-Maryland completes mill; hoisting plant erected at the Brunswick mine; compressor plant completed at the Normandie-Dulmain mine and shaft retimbered.

Jackson—Twenty-four-stamp mill erected at the Moore mine.

Lewiston—Lewiston Dredging Co. erects gold dredge at the Martin ranch and L. Gardella completes gold dredge below Lewiston.

Los Angeles—Los Angeles Graphite Co. completes plant for milling and flotation of graphite ores; Simon Silver-Lead Co. constructs zinc oxide plant at Harbor City.

Randsburg—California Rand Silver Co. completes mill and flotation plant.

Redding—California Bi-Metallic Corporation adds to mining equipment.

San Francisco—Yuba Manufacturing Co. completes and ships two gold dredges and a Diesel-engine power plant to Nome, Alaska, for the Hammon Consolidated Goldfields Co.; Yukon Gold Co. ships two new dredges to the Federated Malay States.

Sutter Creek—Hoisting equipment, headframe and bins erected at the Central Eureka mine.

Tuttletown—Twenty-stamp mill erected at the Pattinson mine.

Valley Springs—Hesperides Mining Co. completes plant for treatment of gravel.

Winthrop—Zinc oxide refinery completed by the Shasta Zinc & Copper Co.

COLORADO

Blackhawk—Cornucopia Mining & Milling Co. completes 50-ton mill.

Bonanza—Colorado Corporation starts to build a 500-ton mill and install a 7½-mile rope tramway from mine.

Durango—American Smelting & Refining Co. commences the erection of a large plant for the operation of the Coolbaugh process.

Empire—Empire Consolidated Mines Co. builds 100-ton plant.

Fairplay—Dredge constructed for South Park Dredging Co.

Georgetown—Fifty-ton mill erected at the St. George mine.

Ouray—Mountain Top Mining Co. enlarges underground plant; Atlas Mining & Milling Co. installs ball mills.

San Miguel—Ophir Loop Mines & Metal Co. adds flotation plant to mill.

Silver Plume—East Butte Copper Co. completes 400-ton mill.

IDAHO

Bonners Ferry—Cynide Gold Mining Co. builds 100-ton mill and cyanide plant.

Featherville—South Park Dredging Co. assembles 9-cu.ft. bucket dredge.

Gilmore—Idaho Minerals Co. builds 50-ton mill and concentrating plant; Latest Out Mining & Smelting Co. installs oil engine, hoist, compressor, electric light plant and rebuilds engine house.

Hailey—Consolidated Mascot Mines Corporation installs 300-hp. oil-engine plant, 500-cu.ft. compressor, and boarding and bunk houses.

Kellogg—Bunker Hill & Sullivan Mining & Concentrating Co. completes new South mill.

Leonia—Idaho Gold & Ruby Mining Co. erects concentrator to save black sands.

Lowman—Boiler and rod mill is added to the surface plant at the Merry Blue mine.

Murray—Paragon Mining Co. rebuilds 100-ton concentrating plant.

Naples—Boulder Creek Gold Mining Co. installs mill and amalgamation plant.

Port Hill—Idaho Continental Co. adds flotation unit to mill.

Salmon—Harmony Mines Co. completes addition of flotation unit to mill; Pope-Shenon Mining Co. converts chloridizing plant to 50-ton concentrator.

Soda Springs—Caribou Placer company builds amalgamation and **hydro-electric plants and camp buildings.**

Talache—Talache Mines Co. builds 200-ton mill and flotation plant at Armstead mine, also provides additional boarding and bunk house to accommodate 100 men.

Yellow Pine—United Mercury Mines Co. installs 70-ton retort.

JOPLIN-MIAMI

Joplin—Bernard Mining Co. completes construction of 150-ton mill and concentrating plant; new equipment added to plant of Golden Rod Mining & Milling Co.

Miami—Barnsdall Zinc Co. completes two mills.

Picher—G. W. Parrish Mining Co. adds new sludge department and erects rope tramway.

MONTANA

Neihart—Flotation mill of 400-ton capacity constructed at the Silver Plume property of the American Zinc, Lead & Smelting Co.

Jefferson—Cyanide mill completed at the Yellow Jacket mine.

Wise River—Boston & Montana company completes 500-ton mill.

MINNESOTA

Babbitt—Mill to handle magnetic ores of Mesabi Iron Co. completed.

Buhl—Surface equipment completed at the Wabigan mine.

Chisholm—Concentrator under construction at the Billings mine; steel headframe erected at the Tener mine.

Hibbing—Drying plant remodeled at the Lamberton mine; crushing unit added to the screening plant at the Hull-Rust pit and screening plant erected at the Sweeney pit.

Keewatin—Steel headframe erected at the Bennett mine.

Marble—Screening plant erected to serve the Hill-Annex pit.

Nashwauk—Additional unit added to the Hawkins concentrator.

NEVADA

Arden—Enlargements to plant made by the U. S. Gypsum Co.

Battle Mountain—Betty O'Neal company builds 100-ton mill and flotation plant.

Candelaria—Candelaria Mines Co. builds 300-ton mill and treatment plant.

Cortez—Consolidated Cortez Silver Mines Co. begins construction of 100-ton plant.

Ely—Reverberatory furnaces completed by Nevada Consolidated, also construction of new concentrator for this company.

Gold Circle—Mill completed by the Big Chief Consolidated company.

Hilltop—Hilltop Nevada company erects 100-ton mill and flotation plant.

Las Vegas—West End Chemical Co. completes calcining plant.

Leadville—Additions made to milling plant of Leadville Mines Co.

Pioche—Tempa Mining & Milling Co. erects mill.

Silver City—Comstock El Dorado company builds leaching plant.

Virginia City—United Comstock company completes 2,000-ton mill and cyanide plant.

Tonopah—Additions made to the milling plants of West End Consolidated and Tonopah Extension companies.

PLANT AND EQUIPMENT

NEW MEXICO

Lordsburg—Anita Copper Co. erects an experimental leaching plant; Calumet & Arizona installs 300-hp. electric double-drum hoist at the 85 mine, and White Syndicate installs a pneumatic flotation system at the Last Chance mine.

OREGON

Baker—Fifty-ton mill erected at the Azurite mine.
Grants Pass—Stamp mill erected at the Jewett mine.
Homestead—Mill erected at La Bellevue, near Granite.

SOUTH DAKOTA

Lead—Homestake Mining Co. completes new South mill, consisting essentially of stamp mills, rod mills, classifiers and amalgamation and cyanide plant.

UTAH

Alta—Michigan-Utah company constructs new tramway.
Bingham—Utah Copper remodels Magna mill for flotation.
Eureka—Installation of compressor and transmission line; also electrical hoisting equipment completed at Grand Central mine.
Park City—Silver King Coalition company completes 500-ton flotation mill.
Salt Lake City—Plant constructed to produce calcium arsenate from ores from Gold Hill, Utah.

WASHINGTON

Chewelah—Northwest Magnesite Co. installs a Cottrell plant.
Mead—Western Materials Co. completes plant for preparation of magnesite chips.
Newport—Bead Lake Gold & Copper Mining Co. completes 100-ton concentrator.
Republic—Hoisting equipment completed at the Knob Mill mine.

ONTARIO

Cobalt—Headframe and surface plant installed at the Colonial mine.
Kirkland Lake—Electrical equipment installed at the Harvey-Kirkland mine.
Larder Lake—Construction of 150-ton mill and cyanide plant started at the Argonaut mine.
Porcupine—Hollinger Consolidated increases capacity of mill to 4,500 tons per day; additions made to McIntyre company's plant to treat 1,000 tons per day; Northern Canada Power Co. starts construction of new power development at Sturgeon, and Clifton Porcupine company erects mill.

BRITISH COLUMBIA

Anyox—Granby Consolidated company installs hydro-electric plant and builds a 25,000 ft. reservoir.
Bridge River—Lillooet Alluvial Co. installs flume and steel pipe.
Britannia Beach—Mill and concentrating plant under construction for Britannia Mining & Smelting Co.
Cadwaller Creek—Pioneer Gold Mines Co. installs cyanide plant.
Hope—Liberator Mining Co. constructs mill and rope tramway.
Kamloops—Iron Mask Mining Co. completes installation of 300-ton mill.
Kimberley—Crusher plant and ore bins installed at the Sullivan mine, 1,500-ton concentrator also being erected.
Portland Canal—Premier company completes one of the longest rope tramways in the world.
Sandon—Mill and rope tramway of Silversmith Mines Co. completed; compressor plant installed at McAllister mine.
Sidney Inlet—Tidewater Copper Co. improves flume and pipe line and oil flotation plant.
Silverton—Compressor plant installed at the Meteor mine.
Stewart—Bullion plant completed at the Premier mine.
Surf Inlet—Belmont Surf company builds ore bins and rope tramway.
Trail—Foundry being built by Consolidated company; plant for electrolytic treatment of custom zinc ores completed.
Vancouver Island—Mill installed on Bodwell River by J. B. Woodsworth.

MEXICO

Batuca—Progresso Silver Mines Co. installs new power plant.
Durango—Mill of Bacis Gold & Silver Mining Co. is remodeled.
El Oro—Cia. Esperanza adds crushing and milling equipment to its plant.
Nazarit—United Eastern Mining Co. installs surface equipment plant at property near the El Tigre.
Pachuca—Cia. de Real del Monte y Pachuca adds to its crushing equipment at the Loreto mill.
Sonora—Moctezuma Copper Co. completes preliminary units of mill and concentrating plant.

New Machinery

By D. E. A. Charlton
Assistant Editor

MANY OF THE IMPROVEMENTS and advances in mining, milling, smelting, and refining made during 1922 have already been mentioned in the columns of the *Journal-Press* devoted to this important phase of the mining industries. From a general inquiry submitted to the various manufacturers and impressions obtained from the field, it appears that a number of notable achievements are evident. For one thing, there is closer co-operation between manufacturer and user, a better exchange of courtesies, as it were, and each is realizing more than ever the benefits to be obtained by a complete understanding of the other's problems. A striking evidence of this is the increasing employment, by the manufacturers, of service engineers who devote the greater part of their time to problems in the field, working with the operators and transmitting the experience of both to the manufacturer. The result has been the production of more capable machinery and devices.

The last few years have demonstrated a tendency on the part of manufacturers to expand not only in the volume of their products but in the diversity of the machines. This has been due to the closer observation of operators in the different industries and a tendency to examine "what the other fellow is doing." Altogether, it is a healthy sign and may be due in good part—we say this with pardonable conceit—to the technical press.

Important in the developments of electrical apparatus was the increase in size and guaranteed efficiencies of power-generation and distribution material. These developments were forced by the tendency to concentrate the generation of power in so-called "super-power" systems. Another noteworthy characteristic was the growing use and increased capacities of automatically controlled stations.

In estimating the advance in hydraulic prime-mover design, it is probable that we will find the most important feature to be the progress in design and operation of remote control and completely automatic generating stations. This statement is made in full recognition of the fact that, up to the present time, few if any mining companies have installed stations of either type. However, now that stations of both types have given continuous service over long periods, with only occasional visits for inspection and oiling, the mining industries are certain to take advantage of this development. The field where such plants will be particularly advan-

tageous comprises the mine or mill where the present power arrangements are unsatisfactory, where up to 1,000 kw. is required, and where a site for development exists not directly adjacent to the point of use.

The range of sizes available in Diesel engines is practically unchanged, being from 300 to 750 hp., depending on the requirements of the purchaser. A number of improvements have been made by the manufacturers, principally changes of design which permit free expansion and contraction of the metal exposed to the intense heat of the combustion chamber and alterations in the design of the fuel valve. Considering the several advantages offered by this type of prime mover—saving of fuel, economy of operation, elimination of stand-by losses, compactness of space, and accessibility of working parts—a steadily increasing demand may reasonably be anticipated for the Diesel engine in the mining field.

In general, there has been no outstanding change in the design of mine hoists, and the developments have consisted principally in improvements in the several details. For the most part, the smaller types are fairly well standardized and the larger hoists are built to specifications agreed upon by the manufacturers and purchasers.

Several new pumps have been developed for mine service, among which may be mentioned the following: A vertical centrifugal sinking pump, having a capacity from 2,000 to 10,000 gal. per minute, which is similar to the single-stage, double-suction volute, motor-driven type except that the thrust bearings have been designed for the vertical working position; a volute multi-stage pump in which the velocity of the water from each runner is converted to pressure before entering the next runner by means of volute passages, the runners being back to back to eliminate all thrust, and an inclined sinker pump, the motor of which is mounted in a stirrup or saddle hung between steel channels and entirely protected from dripping water by a steel housing. The mechanical difficulties inherent to the design of centrifugal sand pumps have been overcome by one manufacturer through the elimination of the customary stuffing box, using in its stead a centrifugal seal which has no rubbing contact.

To meet the growing demand for piping materials to give the best service for superheated steam at working pressures between 300 and 400 lb., a number of new patterns have been designed. Gate valves are available in sizes 1½ to 15 in.; globe valves in sizes 2 in. and smaller; pop safety and non-return valves, screwed fittings in sizes 2½ in. and smaller, and flanges and flanged fittings in sizes 1½ to 15 in.

Advances in compressor design during the year include the following: Steam-driven, direct flow, angle compound compressors which secure all the advantages of exact balance, freedom from vibration and high air efficiency of the power-driven angle machine; duplex compressors of medium size arranged for either belt or direct-connected motor drive, equipped with five-step clearance control system of regulation which secures automatic unloading, and direct-connected, oil-engine-driven two-stage compressors.

Probably no department of underground mining has received more attention than drilling. In this particular, competition is most keen among rock-drill manufacturers, and most of them are fully alive to their responsibilities. "A drill for every purpose" seems to be the slogan. The trend in the making of hammer drills has been toward lighter mountings, improvement in valve design and valve action; in drifters and stopers, efforts toward stronger rotation and the substitution of air-feed throttle control for the mechanical brake hitherto employed to regulate the feed of the machine or the speed of advance.

It is generally conceded that the heat treatment of drill steel at mines is in great need of improvement, and it is to be hoped that in the near future arrangements will be devised whereby proper and uniform treatment can be accurately and, as nearly as possible, automatically secured. Mining engineers ought to devote more study to the shape of the bit, for it is believed that considerable improvement in drilling economy is possible in this direction. Under the conditions mentioned above it is possible with certain high-grade drill steels to obtain excellent results. The question of analysis (carbon content, etc., and other data) of such high-grade steels can for the present be considered as settled. It is not out of the question that a certain small amount of alloy might improve the steel. There is, however, no actual evidence as to this effect, as all that has been brought out on the subject has a commercial color. Several mills are devoting their attention to the matter, and we hope the next year will bring some new light on this subject. The development of high-carbon alloy drill steel has to be preceded by perfection in the heat treatment. In other words, the possibilities of carbon drill steel have not been fully developed, and the greater care necessary in working alloy drill steels must not be overlooked.

The use of scrapers in underground mining is rapidly increasing, the low cost of loading the ore, together with the small cost of equipment necessary, making this system of loading particularly desirable. The small size, portability, and ease of mounting the several types of "slusher" hoists make their use particularly desirable for underground work, and they also have extensive application both underground and on surface. Among the outstanding features claimed for these machines are low air-pressure requirements and economical air consumption, high starting torque, little wear and breakage, light weight, and small size. A further development of the scraper hoist is evident in a somewhat heavier type, ranging up to 25 hp., provided with a double drum and operated by electricity as well as by air.

There have been marked changes in the construction and, to some extent, in the design of mechanical loaders. Considering that the development of underground mechanical shovels has taken place in but a few years, the progress has been excellent, and though it is generally admitted that there is no one machine which is entirely suited for all conditions there are at least four manufacturing companies whose products are conceded to be outstanding.

In the manufacture of various explosives it has always been necessary to maintain the factor of sensitiveness when the explosive was subjected to low temperatures. The elimination of the hazardous practice of thawing frozen dynamite was an accomplishment devoutly desired for commercial as well as humanitarian reasons. The problem of how to retain all the efficiency of the dynamite of nitroglycerin content and eliminate the liability of freezing was one which has

PLANT AND EQUIPMENT

occupied the chemical engineers of explosive makers for considerable time. The final development of a high explosive available in various strengths, and manufactured upon the well-known nitroglycerin or ammonia nitrate base, is a very notable accomplishment.

In open-pit practice, the strengthening of the 30-yd. air-dump car used in stripping operations has been a logical improvement and one which has well met the demands made upon this type of equipment. The reenforcing and redesigning of the floor of the car has resulted in greater wear and increased efficiency.

The use of the term "steam shovel" each year becomes less common in mining as well as in other industries, for the adoption of other means of motive power is becoming more and more popular. Among the advances in 1922 are the gasoline- and the Diesel-driven shovels. The electrically driven shovel, though a new development, does not strictly belong in the machinery chronology of 1922, although a number of advances are evident in the types using electric power. The application of caterpillar and crawling traction trucks to power shovels is a notable improvement, as will be testified by any open-pit operator who has wrestled with track sections in the winter or in rainy seasons.

The use of a four-wheel truck or trolley on continuous-system tramways allows of much greater capacity than formerly. The substitution of this truck will also permit increasing the capacity of existing rope tramways without necessitating an increase in the size of the track ropes. Recent improvements in single-span, gravity, two-bucket tramways include a headgear in a structural-steel frame which represents an improvement over the old method of using a cast-iron base. Asbestos-lined brakes have replaced the old-style wood blocks. Another improvement is in the method of applying the brakes. Instead of employing a counterweight to release the brakes and lever with ratchet and pawl to hold them set, as has been the custom heretofore, the new method is to have the brakes always set by means of the counterweight and by applying force to the lever to release the brake.

A feature which undoubtedly will have an important bearing on the future design of gyratory crushers is the substitution of cast steel in the frame and crown instead of gray iron. Although this is not new practice, for the operator who was willing to pay the price could obtain a cast-steel crusher, in the majority of cases the cast-iron frames and crowns were regarded as standard equipment. One manufacturer at least has adopted the use of cast steel in this particular as a standard.

Concerning mechanical rubber goods there was no development in 1922 in any particular item as applied to the mining industries, but there was a decided growth in the use of both conveyor and elevator belts in the handling of ore, tailings, concentrates, and other material. The economies effected by this method of handling have long been apparent to operators, and more particularly in the handling of low-grade copper ores. With this increase in use have come refinements and improvements in construction and quality, so that the rubber belts of today are giving service far in excess of those of five years ago and, consequently, cut handling costs materially. Another feature of the use of rubber is its adaption as lining material for pumps and in flotation work.

The developments in mechanical screening, particularly with electrical vibration, have been rapid. The best screening equipment is giving continuity of operation, screen life, and freedom from repairs equal to the best crushing and grinding machinery. Close sizing, with, in some cases, even three products and an oversize from one machine, and clean separation, large tonnage capacities, and low power consumption are making the installation of such equipment extremely profitable. The present successful range of dry screening on electrically vibrated machines is from 2-in. to 200-mesh; in wet screening 48-mesh is the present lower limit of application. Electrically vibrated screens are being operated in closed circuit with primary crushers, producing accurately sized feed for secondary breakdown and resulting in increased capacity for both primary and secondary machines; ahead of stamps, bypassing fines direct to concentrating machines with decreased slimes; ahead of jigs and tables, producing accurately sized feed; in closed circuit with ball mills, returning an extremely clean oversize, and in other operations where close sizing increases profits. In the magnetic concentration of iron ores, electrically vibrated screens are being used extensively, as well as in the concentration of gold, silver, copper, lead, and other ores. In the non-metallic field, particularly in dry grinding, applications are even more numerous and cover a wider range of materials and separations.

Certain mechanical improvements have been made in the construction of tables, which have been applied to the concentration of several ores heretofore not generally treated by that method. Such improvements consist in the strengthening and redesigning of all parts subject to wear and strain and the inclosure of the head motion with the wearing parts running in oil. New applications for tables are evident in the treatment of glass sand, feldspar, and aluminum silicate.

A study of several flow sheets reveals the significant fact that in one department only has the metallurgy of the cyanide process become thoroughly standardized, and that is in precipitation. In Mexico the majority of the larger plants discarded shavings several years ago; Canada has never used anything but the Merrill and Crowe processes for precipitation; in Africa, where the use of shavings has been so firmly established for many years, five plants have changed to zinc dust precipitation and a number of others are about to follow. Even in India, where zinc consumptions and cost with shavings have always been remarkably low, the benefits of removing dissolved oxygen are being recognized. The lower zinc consumption, higher-grade precipitate, and elimination of values tied up in zinc boxes cannot long be overlooked, now that the results in Africa have proved that perfect precipitation can be obtained even with the lowest possible strengths in cyanide and alkali.

Actual results in the field indicate that substantial progress has been made in the development of a heavy-duty type of diamond core drill for oil exploration. The ordinary diamond drills are being extensively used for structure testing, and the larger machines, with extra size fittings, are being employed for deep tests in wildcatting and in production drilling. The adaptability of the diamond drill process to both "rotary" and "standard" ground has reduced drilling expense and in many cases speeded up operations remarkably.

Mining Stocks in 1922

Stock	Exch	High		Low		Last	Sales
COPPER							
Ahmeek	Boston	66	May 29	56	Nov. 15	57	12,564
Alaska-Br.Col.	N. Y. Curb	5⅜	Mar.	1⅞	Jan.	1⅞	231,300
Alloues	Boston	32½	Jan. 26	19	Dec. 15	22½	7,731
Anaconda	New York	57	May 31	45	Nov. 27	50⅛	1,974,175
Arcadian Cons.	Boston	4⅛	May 23	2	Mar. 10	3¼	85,765
Ariz. Com'l	Boston	10½	June 5	6	Nov. 2	7⅛	32,680
Big Ledge	N. Y. Curb	*29	Jan.	*4	Dec.	*4	3,035,300
Bingham Mines	Boston	18½	Sept. 11	13	Jan. 5	18	24,375
Calumet & Ariz.	Boston	66	Sept.	50	Nov.	56	27,755
Calumet&Hecla	Boston	301	Aug. 25	248	Nov. 14	289	7,492
Canada Copper	N. Y. Curb	*65	Apr.	*1	Sept.	*2	1,317,983
Centennial	Boston	13½	Feb. 1	8	Nov. 1	8⅛	3,161
Cerro de Pasco	New York	46⅜	Dec. 18	32⅜	Jan. 4	45⅛	59,800
Chile Copper	New York	29½	Nov. 9	15⅛	Jan. 5	27⅛	1,797,600
Chino	New York	33⅜	June 1	22½	Nov. 27	26½	447,800
Copper Range	Boston	46⅜	May 31	35⅛	Dec. 13	36⅛	13,079
Crystal Copper	Boston Curb	2 3/16	Oct.	*52	Jan.	1 7/16	.....
Davis-Daly	Boston	9¼	Jan. 26	2½	Nov. 23	3	137,751
East Butte	Boston	12½	Jan. 26	7⅛	Nov. 28	9	54,234
First National	Boston Curb	*90	Apr.	*35	Dec.	*35	.....
Franklin	Boston	3⅞	Apr. 15	1	Apr. 11	1⅜	31,389
Gadsden Cop.	N. Y. Curb	1⅛	June	*50	Mar.	*70	63,100
Granby Consol.	New York	35	May 24	22	Nov. 14	24⅛	190,800
Greene-Canan.	New York	34⅛	May 29	22	Nov. 1	27⅛	62,850
Hancock	Boston	3½	Mar. 16	1½	Aug. 18	2⅛	5,731
Howe Sound	N. Y. Curb	3¾	Mar.	2⅛	Jan.	2⅜	149,100
Inspira. Consol.	New York	45	June 1	31	Nov. 27	35⅛	230,650
Iron Cap	Boston Curb	9⅛	Sept.	4	Dec.	4⅛	.....
Isle Royale	Boston	26⅞	May 31	18	Nov. 1	21⅛	10,729
Kennecott	New York	39⅜	May 31	25⅛	Jan. 3	36⅜	706,000
Keweenaw	Boston	5⅞	May 5	1	Feb. 24	1⅛	29,432
Lake Copper	Boston	5⅞	May 31	2¼	Feb. 18	3	23,460
Magma Copper	New York	35⅛	Sept. 28	27	Dec. 5	31⅛	66,400
Mason Valley	N. Y. Curb	3⅛	May	1	Oct.	1⅛	193,180
Mass. Consol.	Boston	4⅜	Apr. 13	1⅛	Dec. 26	1⅜	24,249
Miami Copper	New York	31⅜	May 31	25	Nov. 15	27⅛	191,000
Michigan	Boston	7	Apr. 13	*75	July 10	2⅛	35,142
Mohawk	Boston	68	June 5	52	Nov. 15	58	12,412
Mother Lode C	N. Y. Curb	11	.....	6⅛	.....	11	1,170,730
Nevada Consol.	New York	19⅛	June 1	13⅛	Nov. 15	15⅛	374,000
New Cornelia	Boston	20⅛	June 2	15⅛	Dec. 4	17⅛	43,870
North Butte	Boston	15	May 29	8⅛	Oct. 31	9⅛	77,281
Ohio Copper	N. Y. Curb	*60	Dec.	*6	Aug.	*56	1,266,900
Old Dominion	Boston	27	Jan. 25	16	Nov. 27	17⅛	14,015
Osceola	Boston	38⅛	Aug. 23	25	Nov. 28	32⅛	7,879
Quincy	Boston	50	May 31	30	Nov. 15	35	11,111
Ray Consol.	New York	19	May 31	12⅛	Nov. 16	14⅛	300,100
Ray Hercules	N. Y. Curb	2¼	June	1	Feb.	2	280,000
St. Mary's Min. Ld.	Boston	48⅛	May 31	37	Nov. 28	41	17,491
Seneca Copper	Boston	22	Jan.	7½	Oct.	7⅛	6,229
Shannon	Boston	1⅜	May 18	*25	Mar. 10	*53	30,817
Shattuck Ariz.	New York	12	June 2	6½	Nov. 2	8⅛	56,750
South Lake	Boston	1⅛	May 18	*25	Dec. 19	*30	13,370
Superior&Bost	Boston	2⅛	Oct. 19	*90	Mar. 31	2⅛	76,872
Tenn. C&C cfs.	New York	12⅛	May 19	8⅜	Nov. 15	10⅜	304,300
Tuolumne	Boston	*92	May 22	*40	Nov. 10	*52	122,686
United Verde X	N. Y. Curb	30½	May	25½	Oct.	27⅛	44,470
Utah Consol.	Boston	3½	June 5	1	Feb. 21	1⅛	17,026
Utah Copper	New York	71⅛	Sept. 5	59	Nov. 27	65	658,600
Utah Met. & T.	Boston	2⅜	Apr. 13	*80	Dec. 12	*95	96,065
Victoria	Boston	2⅛	Jan. 30	*75	Nov. 27	1	10,748
Winona	Boston	2⅜	Apr. 15	*25	Jan. 16	1½	62,861
Wolverine	Boston	16	May 31	7⅛	Nov. 29	8	7,731
NICKEL-COPPER							
Internat.Nickel	New York	19⅛	Apr. 24	11½	Jan. 9	13⅜	303,750
Int. Nickel, pfd	New York	84⅛	Sept. 19	60	Jan. 3	68⅜	161,850
LEAD							
Carnegie L.&Z.	Pittsburgh	6⅜	Sept.	2⅛	Jan.	4⅛	.....
National Lead	New York	129½	Dec. 15	85	Jan. 5	128	326,400
Natl. Lead, pfd	New York	117	Oct. 5	108	Jan. 6	112	13,400
St. Joseph Lead	New York	20¼	Sept. 25	12⅜	Jan. 9	19	128,110
ZINC							
Am. Z. L. & S.	New York	21	Sept. 20	12⅛	Jan. 3	16	121,600
Am.Z.L.&S.pfd	New York	57	Sept. 20	36	Jan. 17	48⅛	52,800
Butte C. & Z.	New York	10⅛	Dec. 12	5⅛	Mar. 1	10	259,700
Butte&Superior	New York	55½	Oct. 5	20⅜	Jan. 4	31⅛	247,900
Callahan Zn.Ld	New York	11⅞	May 29	5⅛	Feb. 14	10	719,640
Iron Silver	Detroit	*50	Dec.	*25	Mar.	*50	.....
New Jersey Zn	N. Y. Curb	175	Dec.	141	June	*172	7,255
Yellow Pine	Los Angeles	*76	Oct.	*37	Mar.	*75	.....
SILVER							
Batopilas Mng.	New York	1⅜	Mar. 23	¼	Dec. 14	⅜	86,410
Beaver Consol.	Toronto	*38⅛	Sept.	*19	Feb.	*30	.....
Candelaria	N. Y. Curb	*71	Oct.	*19	Jan.	*29	4,405,200
Coniagas	Toronto	2.10	Oct.	1.00	Jan.	1.90	.....
Crown Reserve	Toronto	*31½	Nov.	*14¼	Jan.	*31	.....
Kerr Lake	N. Y. Curb	4⅛	Apr.	3	Mar.	3½	35,700
La Rose	Toronto	*64	Mar.	*21½	Nov.	*22	.....
McKinley-Dar.	Toronto	38	Apr.	*14½	Jan.	*20	.....
Min.Corp.Can.	Toronto	1.15	Jan.	*80	Sept.	*85	.....
Nipissing	N. Y. Curb	6⅞	Mar.	5⅛	July	5⅛	187,050
Ont. Silver	New York	9⅜	Mar. 25	4½	Jan. 5	5⅛	51,700
Temiskaming	Toronto	*47	Sept.	*29	Jan.	*32	.....
Trethewey	Toronto	*7	Jan.	*2	Dec.	*2	.....

Stock	Exch.	High		Low		Last	Sales
GOLD							
Alaska Gold	New York	⅛	May 10	⅛	Dec. 28	⅛	89,600
Alaska Juneau	New York	2	May 17	⅛	Jan. 4	1⅛	248,100
Atlas	Toronto	*41½	Sept.	*7	Jan.	*15	.....
Carson Hill	Boston	16⅞	Mar. 29	5⅛	Nov. 20	6⅛	253,823
Cresson Cons.G	N. Y. Curb	3	Jan.	2⅛	Oct.	2 3/16	270,300
Dome Mines	New York	46½	Nov. 6	18½	Jan. 4	42⅛	791,600
Golden Cycle	Colo. Sprgs	1.02½	Aug.	*50	Dec.	*88	.....
GoldfieldConsol	N. Y. Curb	*12	Apr.	*3	Jan.	*6	314,900
HollingerConsol	Toronto	14.35	Sept.	7.74	Jan.	12.20	.....
HomestakeMin	New York	82	Nov. 15	55	Jan. 3	80	29,400
Keora	Toronto	*15½	Mar.	*8	June	*9½	.....
Kirkland Lake	Toronto	*49	Feb.	*27	Jan.	*39	.....
Lake Shore	Toronto	3.06	Sept.	1.26	Jan.	2.85	.....
McIntyre-Porcu	Toronto	22.00	Mar.	13.85	Mar.	17.50	.....
Porcu. Crown	Toronto	*31	Mar.	*12	Jan.	*15½	.....
Portland	Col. Sprgs.	*50	Sept.	*20	June	*38	.....
Schumacher	Toronto	*77	June	*31	Jan.	*45	.....
Teck-Hughes	Toronto	*98	Sept.	*15½	Jan.	*83½	.....
Tom Reed	Los Angeles	1	Feb.	*36	Jan.	*73	.....
United Eastern	N. Y. Curb	2½	Jan.	1⅜	Apr.	2 5/16	1,403,310
Vipond Consol.	Toronto	*78	.....	*54	.....	*69½	.....
WhiteCapsMin	N. Y. Curb	*18	Oct.	*3	Feb.	*10	330,200
Wright-Hrgvs.	Toronto	3.40	.....	1.75	.....	3.08	.....
Yukon Gold	N. Y. Curb	1¼	June	*50	Nov.	*75	94,185
GOLD AND SILVER							
Boston-Mont.	N. Y. Curb	5	Jan.	*12	Dec.	*17	4,153,700
Consol. Va.	San Fran.	*54	Jan.	*10	June	*10½	.....
Cont. Mines	N. Y. Curb	5⅛	Dec.	4⅛	Oct.	4⅞	86,760
Dolores Esper.	N. Y. Curb	3½	Aug.	*82	Feb.	1⅞	261,400
MacNamara M	N. Y. Curb	*14	Mar.	*4	Dec.	*5	532,500
Tonopah Belmt	N. Y. Curb	1⅞	June	1 1/16	Jan.	1⅛	119,800
Tonopah Div.	N. Y. Curb	*96	Aug.	*46	Mar.	*72	1,128,300
Tonopah Exten	N. Y. Curb	4 1/16	Dec.	1 1/16	Feb.	3⅛	437,900
Tonopah Min.	N. Y. Curb	2 1/16	Sept.	1⅜	Jan.	2	101,030
WestEndConsol	N. Y. Curb	1 13/16	Mar.	*70	Feb.	1⅛	853,380
SILVER-LEAD							
Caledonia	N. Y. Curb	*20	Aug.	*4	Feb.	*8	107,000
Cardiff M.&M.	Salt Lake	1.07½	Feb.	*31	Dec.	*31	.....
Chief Consol.	Boston Curb	6	Sept.	3	Jan.	5	.....
Col. Rexall	Salt Lake	*35	Mar.	*13	Dec.	*22	.....
Consol. M.&S.	Montreal	28½	Nov.	18½	Jan.	27	.....
Eagle&BlueBell	Boston Curb	3½	June	2½	Jan.	3	.....
Federal M.&S.	New York	16½	May 19	9	Jan. 3	9⅞	15,800
Federal M.&S. pfd	New York	62¾	Sept. 20	37	Jan. 13	46½	122,800
Florence Silver	Spokane	*39	Sept.	*17	Jan.	*36	40,600
Hecla Mining	N. Y. Curb	9	Nov.	4½	Jan.	8⅛	262,150
Irn.BlossomCn	N. Y. Curb	*38	Aug.	*16	Mar.	*35	196,000
Marsh Mines	N. Y. Curb	*31	May	*4	Jan.	*6	1,984,200
Park City	Salt Lake	3.75	.....	3.35	.....	3.35	.....
Prince Consol.	Salt Lake	*14½	Jan.	*3	Apr.	*9	.....
Simon Silver Ld	N. Y. Curb	*90	Apr.	*29	Nov.	*31	135,825
Stewart Mines	N. Y. Curb	*16	Apr.	*2	Jan.	*6	1,195,000
Tamarack-Cstr	Spokane	3½	July	1⅞	Feb.	3⅛	.....
Tintic Std.	Salt Lake	3.42½	Oct.	1.80	Jan.	2.97½	.....
Utah Apex	Boston	4	Mar. 22	1 1/16	Oct. 20	3	81,689
IRON							
Beth. Steel "B"	New York	82½	May 12	55½	Jan. 3	62½	2,112,670
Char. Iron	Detroit	2½	Jan.	⅜	Jan.	1	.....
Char. Iron, pfd.	Detroit	3½	Jan.	1⅛	Dec.	2	.....
Col.Fuel&Iron	New York	37	May 18	24	Jan. 10	27½	267,400
Col. F. & I., pfd	New York	106	May 3	101⅞	Apr. 11	104½	400
Gt.North'n I.O	New York	45⅜	.....	28⅞	.....	30½	3,500
Inland Steel	N. Y. Curb	58	.....	41½	.....	45½	5,670
Mesabi Iron	N. Y. Curb	13½	Aug.	9⅜	Sept.	12⅛	109,700
Replogle Steel	New York	41	Jan. 20	21	Nov. 27	24	751,900
Republic I. & S.	New York	78⅜	June 2	43½	Nov. 27	48⅛	1,544,750
Republic I.&S. pfd	New York	95½	June 2	74	Feb. 24	90⅛	97,700
Sloss-Sheffield, S. & I.	New York	54½	May 13	34½	Mar. 7	39⅜	153,900
U.S.Steel	New York	111½	Oct. 16	82	Jan. 6	106⅛	8,215,810
U.S.Steel, pfd.	New York	123	Sept. 19	114¼	Jan. 3	121⅞	156,900
Vir. I. C. & C.	New York	94½	Jan. 18	43	Mar. 27	54	45,200
Vir. I.C.&C., pf	New York	86	Oct. 31	66	May 17	80	8,659
VANADIUM							
Vanadium Corp	New York	53⅛	Aug. 30	30¼	Jan. 10	35	1,376,600
ASBESTOS							
Asbestos Corp.	Montreal	73½	Sept.	44	Feb.	65	.....
Asbestos C.,pf.	Montreal	90	July	73½	Mar.	86	.....
SULPHUR							
Freeport Texas	New York	27¼	Oct. 13	12⅛	Jan. 21	20⅜	96,400
Texas Gulf	New York	67⅛	Nov. 7	38⅛	Jan. 4	61	1,176,231
PLATINUM							
S. Am. Gold & Platinum	N.Y. Curb	5⅛	Jan.	2⅛	Dec.	3	167,780
MINING, SMELTING AND REFINING							
Amer. Metal	New York	53⅛	Dec. 26	44	Sept. 1	51⅛	98,400
Am. Metal, pf.	New York	115⅛	Dec. 27	107	Aug. 17	114½	8,800
Am.Sm. & Ref.	New York	67⅛	May 18	43¼	Jan. 5	56⅛	696,800
Am.S.Sec.pfd.A	New York	101¼	Nov. 9	81	Feb. 8	101⅛	10,872
U.S.Sm.R.&M.	New York	45⅜	May 29	32⅛	Feb. 11	37	82,280
U.S.Sm.R&Mp	New York	50	July 7	42⅛	Feb. 1	47⅛	13,100

*Cents per share.

Mining Dividends

Dividends of Mining and Metallurgical Companies in the United States, 1921 and 1922

Company Name	Situation	Shares Issued	Par Value	Dividends Paid 1921 Per Share	1921 Total	1922 Per Share	1922 Total	Total to Date	Latest Date	Latest Amount
Ahmeek, c	Mich.	200,000	$25	.....	.....	$2.00	$400,000	$12,550,000	Dec. '22	$1.00
American Metal	U. S.	140,000	100	$6.00	$840,000	5.50	1,364,000	(a)	Dec. '22	.75
American Metal, pfd	U. S.	50,000	100	.....	.....	3.50	175,000	(a)	Dec. '22	1.75
Am. Sm. & Ref	U. S.-Mex.	609,980	100	1.00	609,980	.....	.....	46,465,579	Mar. '21	1.00
Am. Sm. & Ref., pfd	U. S.-Mex.	500,000	100	7.00	3,500,000	7.00	3,500,000	79,296,386	Dec. '22	1.75
Am. Smelters, pfd., A	U. S.	95,994	100	6.00	575,964	6.00	584,284	73,456,634	Oct. '22	1.50
Am. Smelters, pfd., B	U. S.	30,974	100	5.00	154,870	5.00	159,420	14,448,528	Oct. '22	1.25
Bunker Hill & Sullivan, l.s	Ida.	327,000	10	3.00	981,000	3.00	981,000	27,155,250	Dec. '22	.25
Caledonia Mining, l.s	Ida.	2,605,000	1	.01	26,050	.....	.....	4,308,306	Jan. '21	.01
Calif. Rand. Silver	Cal.	1,280,000	1	.52	665,600	.84	1,075,200	2,272,000	Dec. '22	.12
Calumet & Arizona, c	Ariz.	642,521	10	2.00	1,285,043	2.00	1,285,044	48,200,557	Dec. '22	.50
Calumet & Hecla, c	Mich.	100,000	25	.....	.....	10.00	1,000,000	153,250,000	Dec. '22	5.00
Central Eureka, g	Cal.	392,616	1	.06	23,557	.09	35,335	1,122,631	Dec. '22	.03
Champion, c	Mich.	100,000	25	.....	.....	6.00	600,000	26,450,261	Mar. '22	6.00
Chief Consolidated, s.g.l	Utah	884,022	1	.20	176,805	.30	265,206	2,313,529	Nov. '22	.30
Colorado Fuel and Iron	Col.	34,235,500	100	1.30	51,353,250	.....	.....	(a)	May '21	.75
Colorado Fuel and Iron, pfd	Col.	2,000,000	100	8.00	160,000	8.00	160,000	(a)	Nov. '22	2.00
Columbus-Rexall, s.l.c	Utah	586,235	1	.....	.....	.03	17,567	32,223	Aug. '22	.03
Copper Range, c	Mich.	395,000	25	.....	.....	1.00	394,422	27,392,767	Mar. '22	1.00
Cresson Consol., g	Col.	1,220,000	1	.....	.....	.40	488,000	9,345,163	Oct. '22	.10
Dragon Con., s.c.l.g	Utah	1,875,000	1	.....	.....	.03	56,250	262,500	June '22	.03
Eagle & Blue Bell, l.s	Utah	893,146	1	.05	44,657	.05	44,657	1,652,300	Nov. '22	.05
Eagle-Picher Lead	Okla.-Mo.	1,000,000	100	6.00	60,000	6.00	60,000	(a)	Oct. '22	1.50
Federal M. & Sm., pfd	Ida.	120,000	100	4.00	480,000	4.75	570,000	16,983,837	Dec. '22	1.25
Gold Chain, s.l.g	Utah	1,000,000	25	.01	10,000	.....	.....	140,000	Jan. '21	.01
Golden Cycle, g	Col.	1,500,000	1	.08	120,000	.08	120,000	9,753,300	Dec. '22	.02
Grand Central, g	Utah	500,000	1	.01	5,000	.....	.....	1,830,250	Jan. '21	.01
Granite Gold Mining Co	Col.	1,650,000	1	.03	49,500	.....	.....	418,500	Feb. '21	.03
Hecla Mining, l.s	Ida.	1,000,000	0.25	.50	500,000	.95	950,000	10,455,000	Dec. '22	.50
Homestake, g	S. D.	251,160	100	2.00	502,320	3.50	879,060	43,803,724	Dec. '22	3.50
Internatl. Nickel, pfd	U. S.-Can.	89,126	100	6.00	534,756	6.00	534,756	9,090,738	Nov. '22	1.50
Iron Blossom, s.l.g	Utah	1,000,000	0.10	.025	25,000	.05	75,000	3,375,000	Oct. '22	.05
Marsh Mines Con	Ida.	1,980,000	0.25	.02	40,000	.....	.....	40,000	June '21	.02
Miami Copper	Ariz.	747,114	50	2.00	1,494,228	2.00	1,494,228	25,939,115	Nov. '22	.50
Mohawk, c	Mich.	100,000	25	.....	.....	3.00	300,000	9,975,000	Nov. '22	1.00
Mother Lode Coal, c	Alaska	2,500,000	.....	.....	.....	1.00	2,500,000	2,500,000	Dec. '22	.50
National Lead	U. S.	206,554	100	6.00	1,239,324	6.50	1,342,601	12,341,601	Dec. '22	2.00
National Lead, pfd	U. S.	243,676	100	7.00	1,705,732	7.00	1,705,732	25,585,980	Dec. '22	1.75
New Cornelia Copper	Ariz.	1,800,000	5	.....	.....	1.00	180,000	1,530,000	Nov. '22	.25
New Jersey Zinc	U. S.	454,664	100	8.00	3,498,656	8.00	3,637,312	(a)	Nov. '22	2.00
North Star, g	Cal.	250,000	10	.20	50,000	.20	50,000	5,712,040	June '22	.20
Oroville Dredging, g	Cal.	715,636	£1	9d.	£26,836	3s.	£107,345	£851,178	Sept. '22	9d
Osceola Consol., c	Mich.	96,150	$25	.....	.....	$2.00	$192,300	$17,948,675	Dec. '22	$1.00
Phelps Dodge Corp	U. S.	500,000	100	5.50	$2,475,000	4.00	2,000,000	100,846,000	Oct. '22	1.00
Rochester Silver	Nev.	1,775,079	1	.10	177,508	.075	133,131	310,639	Dec. '22	.025
Silver King Coa	Utah	1,250,000	5	.15	187,500	.15	182,415	15,568,475	July '22	.15
St. Joseph Lead	Mo.	1,549,369	10	1.00	1,549,364	1.25	1,936,711	25,241,086	Dec. '22	.50
Tamarack & Custer, l.s	Ida.	1,776,288	1	.04	75,091	.....	.....	590,209	Jan. '21	.04
Texas Gulf Sulphur	Texas	635,000	10	1.00	635,000	5.00	3,175,000	3,810,000	Dec. '22	2.00
Tintic Standard, l.s	Utah	1,174,700	1	.15	176,208	.15	117,470	1,832,277	Dec. '22	.10
Tonopah-Belmont, s.g	Nev.	1,500,000	1	.10	150,000	.15	225,000	10,568,063	July '22	.05
Tonopah Extension, g.s	Nev.	1,392,715	1	.20	258,544	.20	258,544	3,087,341	Oct. '22	.05
Tonopah Mining, g.s	Nev.	1,000,000	1	.10	100,000	.15	150,000	15,175,000	Oct. '22	.075
United Eastern, g	Ariz.	1,363,000	1	.60	817,800	.60	817,800	4,770,500	Oct. '22	.15
U. S. Sm., Ref. & Min	U. S.-Mex.	351,115	50	.50	175,558	.....	.....	15,315,776	Jan. '21	.05
U. S. Sm., Ref. & Min. pfd	U. S.-Mex.	486,350	50	3.50	1,702,225	3.50	1,702,225	28,285,717	Oct. '22	.875
United Verde, c	Ariz.	300,000	.....	6.00	1,800,000	4.50	1,350,000	(a)	Dec. '22	1.50
United Verde Ext., c	Ariz.	1,050,000	0.50	1.00	1,050,000	1.00	1,050,000	13,755,000	Nov. '22	.25
Utah Copper	Utah	1,624,490	10	2.50	4,061,225	2.00	3,248,980	118,819,868	Dec. '22	.50
Vanadium Corp	Col. and Peru	373,334	.....	1.00	373,334	.....	.....	1,953,337	Jan. '21	1.00
West End Cons., g.s	Nev.	1,788,486	5.00	.....	.....	.15	268,273	1,788,486	Dec. '22	.05
Canadian, Mexican, South and Central American Mining Companies										
Amparo, g.s	Mex.	2,000,000	$1	$0.12	$240,000	$0.17	$340,000	$4,292,177	Dec. '22	$0.05
Asbestos Corporation	Que.	30,000	100	8.00	240,000	6.00	180,000	870,000	Oct. '22	1.50
Asbestos Corp'n., pfd	Que.	40,000	100	9.00	360,000	7.00	280,000	1,640,000	Oct. '22	1.75
Belmont Surf Inlet, g	B. C.	2,500,000	1	.02½	62,500	.025	62,500	625,000	Oct. '22	.025
Cerro de Pasco, c	Peru	898,230	.....	.50	449,115	.....	.....	18,704,427	Mar. '21	.50
Dome Mines, g	Ont.	400,000	10	5.00	476,668	2.25	1,072,501	3,468,335	Oct. '22	.50
El Oro M. & R. R., g.s	Mex.	1,147,500	£1	1s.	£57,375	.....	.....	£2,070,500	Nov. '21	1s.
Hollinger Consol., g	Ont.	4,920,000	$5	$0.65	$3,198,000	$0.65	$3,198,000	$19,756,000	Dec. '22	$5.05
Howe Sound, c	B. C.	1,984,150	1	.05	99,208	.....	.....	1,190,490	Jan. '21	.05
Kerr Lake, s	Ont.	600,000	5	.50	300,000	.50	300,000	8,985,000	Oct. '22	.50
Lake Shore, g	Ont.	2,000,000	1	.06	120,000	.04	80,000	480,000	Nov. '22	.02
Lucky Tiger-Comb., g	Mex.	715,337	10	1.06	758,257	.41	293,290	8,521,120	Oct. '22	.10
McIntyre Porcupine, s	Ont.	3,640,283	1	.15	546,042	.15	546,042	3,088,113	Sept. '22	.05
Mexico Mines of El Oro, g.s	Mex.	210,000	£1	9s.	£94,500	12s.6d.	£131,250	(a)	.... '22	7s.6d.
N. Y. & Hond. Ros., s. g	C. A.	200,000	$10	$0.30	$60,000	$0.75	$150,000	$5,420,000	Oct. '22	$0.25
Nipissing Mines, s	Ont.	1,200,000	5	.95	1,140,000	.90	1,080,000	24,360,000	Oct. '22	.30
Ouro Preto Gold, pfd	Brazil	39,429	£1	4s.6d.	£9,598	2s.	£4,266	(a)	May '22	2s.
Pato Mines, g	Colombia	100,000	1	21s.	105,000	14s.	70,000	£330,000	June '22	7s.
Premier, g	B. C.	5,000,000	$1	$0.08	$400,000	$0.40	$2,000,000	$2,400,000	Sept. '22	$0.15
Silversmith, s. l	B. C.	2,550,000	0.25	.01	25,000	.02	50,000	75,000	Oct. '22	.01
Wright-Hargreaves, g	Ont.	2,750,000	1	.....	.....	.15	412,500	412,500	Oct. '22	.05
Holding Companies										
Exploration Co	Mex.	750,000	10s.	1s.	£37,500	.....	.....	£478,125	Mar. '22	1s.
General Development	U. S.	120,000	$25	.....	.....	.75	90,000	$5,123,917	Nov. '22	$0.25
St. Mary's Min. Land	Mich.	160,000	25	$1.00	$160,000	2.00	320,000	12,800,000	April '22	2.00

(a) Information missing. c, copper; l, lead; s, silver; g, gold.

THE MARKET REPORT

Daily Prices of Metals

Jan.	Copper, N. Y., net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
11	14.50	37.75	39.00	7.50	7.40	6.85
12	14.50	38.00	39.25	7.55	7.45	6.75 @6.80
13	14.50	38.00	39.25	7.55	7.50	6.75 @6.80
15	14.375@14.50	37.75	39.00	7.55	7.50	6.75 @6.80
16	14.375	37.625	38.75	7.60	7.55	6.70 @6.75
17	14.375	37.625	38.625	7.60	7.55	6.70 @6.75

*These prices correspond to the following quotations for copper delivered: Jan. 11th, 12th and 13th, 14.75c.; 15th, 14.625@14.75; 16th and 17th, 14.625.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin quotations are for prompt deliveries. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electro-lytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
11	64 1/4	64 7/8	71	181	182 5/8	27	26 1/2	35 5/8	33 7/8
12	64 1/8	64 3/4	70 3/4	181 7/8	183 5/8	27 1/8	26 5/8	35	33 1/2
15	64	64 5/8	70 5/8	181 1/2	182 7/8	26 7/8	26 3/8	35	33 3/8
16	63 1/2	64 1/8	70 3/8	180 3/4	182 1/2	26 3/4	26 1/4	35 1/8	33 5/8
17	63 3/8	64	70 5/8	180 5/8	182 1/4	26 1/2	26 1/8	35 3/8	33 1/2

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver			Jan.	Sterling Exchange "Checks"	Silver		
		New York Domestic Origin	New York Foreign Origin	London			New York Domestic Origin	New York Foreign Origin	London
11	4.67 3/16	99 5/8	65 1/8	31 9/16	15	4.67	99 5/8	67 1/8	32 1/2
12	4.67 1/2	99 5/8	65 3/8	31 11/16	16	4.65 1/2	99 5/8	66 3/4	32 1/2
13	4.67 1/8	99 7/8	65 1/2	31 7/8	17	4.64 5/8	99 1/8	65 1/2	32

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, Jan. 17, 1923

All the major non-ferrous metal markets with the exception of lead show a decided weakness that may be almost wholly ascribed to the disquieting situation abroad. There has been no change in the position of lead, which is still exceptionally strong. The weakness of the London market has affected that in New York.

Copper

Copper is easier to obtain. Whereas last week practically all producers were asking and receiving 14.75c. for their metal, this price can be shaded today. In one or two directions 14.625c. delivered can be done. However, several large producers are adhering to the higher quotation, at which they were able to transact some business earlier in the week. Although the tense European situation has not yet had any direct influence on the market, it is evident that producers are somewhat worried over the outlook, for German purchases of copper are an important factor in export trade. European sales of copper have been quiet, England remaining practically out of the market. The consolidation of Anaconda and Chile Copper, as at last officially announced, has not had a stimulating result on prices, probably because the amalgamation had been known and discounted by the trade for several weeks. The new arrangement does not alter the copper situation, as it neither adds to nor subtracts from the amount of metal that is available for consumption. A sale of a good-sized lot of copper for delivery through the second half of the year at 14.75c. delivered, was an interesting feature of the week.

Lead

The official contract price of the American Smelting & Refining Co. continues at 7.50c. per lb., New York.

The shortage in lead shows no signs of being diminished. A measure of its acuteness is to be found in the great variation to be observed in the prices quoted for lead not only in the New York market but in that at St. Louis. In New York by far the greatest amount of lead was sold at 7.50c., although quotations have been made as high as 8c. One large producer sold merely a handful of lead during the week, as his stocks are exhausted and he has made all the commitments he cares to for the time being. A few sales of several hundred tons each—about 1,500 tons in the aggregate—were made by other producers to average about 7.65c. New York. As our price is a weighted one, it does not indicate the large premiums that are being asked for prompt shipment of small lots. The demand for lead is phenomenal. Another lead cable plant is to be erected in New Jersey soon, and still another in the Middle West. The automobile manufacturers look forward to a splendid year, which would have a beneficial effect upon the demand for lead storage batteries. Spanish lead has been going to Germany almost exclusively, and should the critical situation abroad affect German purchases of lead—of which Germany is a large consumer—Spanish lead may be driven to London and so bring about an easing of the price there, which would aid the situation here.

Zinc

The galvanizers do not seem anxious buyers, and their reluctance to enter the market for a normal quantity of zinc has caused the quotation to recede further. The statistics of the American Zinc Institute show a decline in stocks during December. Production was 42,841 tons; shipments were 44,086; stocks on hand at the beginning of the month were 19,497, and those on hand at the end of the month, 18,252 tons. It is to be noted, however, that the shipments for December included 10,246 tons for export. Without the support of the

sales abroad, a different picture would have been presented. Last week export buying was again in evidence. The bulk of the business during the week was done for forward delivery, a condition which is reflected in our quotations. Spot tonnages command premiums of 5 points per month. High-grade zinc business is excellent at 7.75@8.25c. per lb., with customary freight allowances.

Tin

The market is quiet and has fallen off slightly, probably because of the uncertainty of the political situation near the most important market—London.

Arrivals of tin in long tons; Jan. 12, Straits, 600; 13th, Straits, 50; China, 50; 15th, China, 500, Straits, 600; total so far in January, 4,575 tons.

Gold

Gold in London: Jan. 11th, 88s. 6d.; 12th, 88s. 9d.; 15th, 88s. 8d.; 16th. 89s. 3d.; 17th, 89s. 5d.

Foreign Exchange

On Jan. 16th, cable quotations on francs were, 6.82c.; lire, 4.89c.; marks, 0.0063c.; and Canadian dollars, ⅞ per cent discount.

Silver

Continued demand from the Indian bazaars advanced the price on Jan. 15 to new high levels for the year—32½d. in London and 67⅛c. in New York. Since that date prices have declined. The future of the market depends upon the strength of the Indian demand, as China exchange rates do not warrant purchases of silver at current levels.

Mexican Dollars—Jan. 11th, 49⅝; 12th, 50; 13th, 50⅛; 15th, 51¼; 16th, 51; 17th, 50c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—General market for 99 per cent grade, 23c. per lb. London quotations, £92 10s.

Antimony — Chinese and Japanese brands, 6⅝@7c. W. C. C., 7@7.5c. Cookson's "C" grade, spot, 7⅞@8⅛c.

Bismuth—$2.50 per lb. London quotes 10s.

Cadmium—$1.15 per lb. London quotes 4s. 6d. @ 5s. 6d.

Iridium—$250@$275 per oz.

Nickel—Standard market, ingot and shot, 36c.; electrolytic, 39c. Outside market quiet at 32@34c. per lb.

Osmium—$80@$85 per oz., Los Angeles. Supply scarce.

Palladium—$65@$70 per oz.

Platinum—$110 per oz.

Quicksilver—$72 per 75-lb. flask. San Francisco wires $71. London £11 10s.

Selenium—$2 per lb.

The prices of **Cobalt, Molybdenum, Monel Metal, Radium, Rhodium, Tellurium** and **Thallium** are unchanged from prices given Jan. 6.

Metallic Ores

Chrome Ore—Indian chrome ore, $18.50 per ton, c.i.f. Atlantic ports. Rhodesian and New Caledonian, $26 per ton. Market quiet.

Manganese Ore—30c. per long ton unit, seaport, plus duty. Chemical ore, $75@$80 per gross ton.

Molybdenum Ore—70c. per lb. of MoS_2 for 85 per cent MoS_2 concentrates.

Tungsten Ore — Wolframite, $7.50; scheelite, $8.50@$8.75 per unit of WO_3, f.o.b. New York.

Iron Ore, Magnetite, Tantalum, Titanium, Uranium, Vanadium, and **Zircon** ore are unchanged from the quotations published Jan. 6.

Zinc and Lead Ore Markets

Joplin, Mo., Jan. 13—Zinc blende, per ton, high, $46.60; Basis 60 per cent zinc, premium, $43; Prime Western, $41; fines and slimes $40@$38; average settling price, all grades of blende, $41.99. Calamine, basis 40 per cent zinc, $20@$22; average, $22.21.

Lead, high, $98.30; basis 80 per cent lead, $95@$96; average settling price, all grades of lead, $92 per ton.

Shipments for the week: Blende, 11,793; calamine, 31; lead, 1,709 tons. Value, all ores the week, $659,120.

The lead quotation is given at $95 to $96. It is known the former price bought some ore, and it is known some ore sold higher, but the higher level could not be ascertained tonight.

Purchases of zinc blende for next week's delivery aggregated 10,390 tons, added to which buyers have from 15,000 to 18,000 tons outstanding from previous purchases. Stocks have dwindled to a point where the purchasable ore does not exceed the production. There are in the bins approximately 30,000 tons of zinc blende unsold, but it is withheld from the market. Around one-third of the ore sold is yet unproduced.

Platteville, Wis., Jan. 13—Blende, basis 60 per cent zinc, $43.50. Lead, basis 80 per cent lead, $93. Shipments for the week: Blende, 1,221 tons. Lead, none. Shipments for the year: Blende, 1,462 tons. Lead, none. Shipped during the week to separating plants, 1,428 tons blende.

Non-Metallic Minerals

Bauxite — American, crushed and dried, $6.50@$8.75 per gross ton; pulverized and dried, $12@$14; crushed and calcined, $20@$24, all f.o.b. shipping points.

European bauxite offered c.i.f. Atlantic ports, duty paid, $6.50@$9 per metric ton, depending upon grade.

Feldspar—Crude No. 1, $7.50 per long ton delivered at Maine grinding plant. For additional quotations see issue of Jan. 6.

Ground material $16@$19 per short ton, f.o.b. mill, New Hampshire. Demand good.

Fluorspar—No. 1 lump, $30; No. 2, lump, $25, f.o.b. Illinois mines.

Talc—Ground from 150 to 200 mesh, $6.50@$8.50 per ton, bags extra ($1 for 50-lb. paper bags or 10c. each for burlap bags, 12 to the ton). f.o.b. Vermont For other talc prices see issue of Jan. 6

Asbestos, Barytes, Chalk, China Clay Diatomaceous Earth, Emery, Feldspar Fuller's Earth, Graphite, Gypsum, Limestone, Magnesite, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur, and **Tripoli** are unchanged from the Jan. 6 prices.

Mineral Products

Arsenious Oxide (white arsenic)—Actual sales averaged about 12.50@13.50c. per lb. Special prices to calcium arsenate manufacturers.

Nitrate of Soda—$2.60 per 100 lb.

Potassium Sulphate, Copper Sulphate and **Sodium Sulphate** are unchanged from quotations of Jan. 6.

Ferro-Alloys

Ferromanganese — Domestic, 78@82 per cent, $102.50@$107.50 per gross ton, f.o.b. furnace. Spiegeleisen, 19@21 per cent, $36, f.o.b. furnace; 16@19 per cent, $35.

Ferrosilicon—10 to 15 per cent, $38 @$40 per gross ton, f.o.b. works; 50 per cent, $80@$85; 75 per cent, $150.

Ferrotungsten—Domestic, 70@80 per cent W, 85@95c. per lb. of contained W, f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferro-uranium, and **Ferrovanadium** are unchanged from the prices published Jan. 6.

Metal Products

Copper Sheets—22.25c. per lb.; wire 16.75c.

Lead Sheets, Nickel Silver, Yellow Metal and **Zinc Sheets** are unchanged from the prices published Jan. 6.

Refractories

Bauxite Brick, Chrome Brick, Chrome Cement, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the Jan. 6 prices.

The Iron Trade

Pittsburgh, Jan. 16, 1923

Prices are firm and in some lines show an advancing tendency, though advances would probably represent the establishment of delivery premiums rather than an increase in basis prices. Though the steel market is strong, it must undergo the test of the change in opinion in the last fortnight to the effect that there will be no coal mining suspension on April 1. An indeterminate portion of the strength of the steel market lately has been ascribable to fears that there would be a suspension, affecting the production of steel.

Steel ingot production was at a rate of fully 40,000,000 tons a year in December.

Pig Iron—The market has been remarkably quiet in point of tonnage turnover, but also remarkably firm. Bessemer remains at $27.50, Valley. Foundry brings the advanced price of $28, Valley, on small prompt lots, but might go at $27 on a large order. Basic, recently selling at under $25, Valley, has not lately been tested; asking prices are $26 or $27.

Connellsville Coke — Market easier; prompt furnace, $8@$8.50; prompt foundry, $9@$9.25.